US008355114B2

(12) **United States Patent**
Ichinose

(10) **Patent No.: US 8,355,114 B2**
(45) **Date of Patent: Jan. 15, 2013**

(54) **EXPOSURE APPARATUS AND DEVICE MANUFACTURING METHOD**

(75) Inventor: **Go Ichinose**, Fukaya (JP)

(73) Assignee: **Nikon Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 323 days.

(21) Appl. No.: **12/818,579**

(22) Filed: **Jun. 18, 2010**

(65) **Prior Publication Data**

US 2011/0007325 A1 Jan. 13, 2011

Related U.S. Application Data

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(51) **Int. Cl.**
G03B 27/42 (2006.01)
G03B 27/52 (2006.01)

(52) **U.S. Cl.** **355/53**; 355/30

(58) **Field of Classification Search** 355/30, 355/52, 53, 55, 67, 72
See application file for complete search history.

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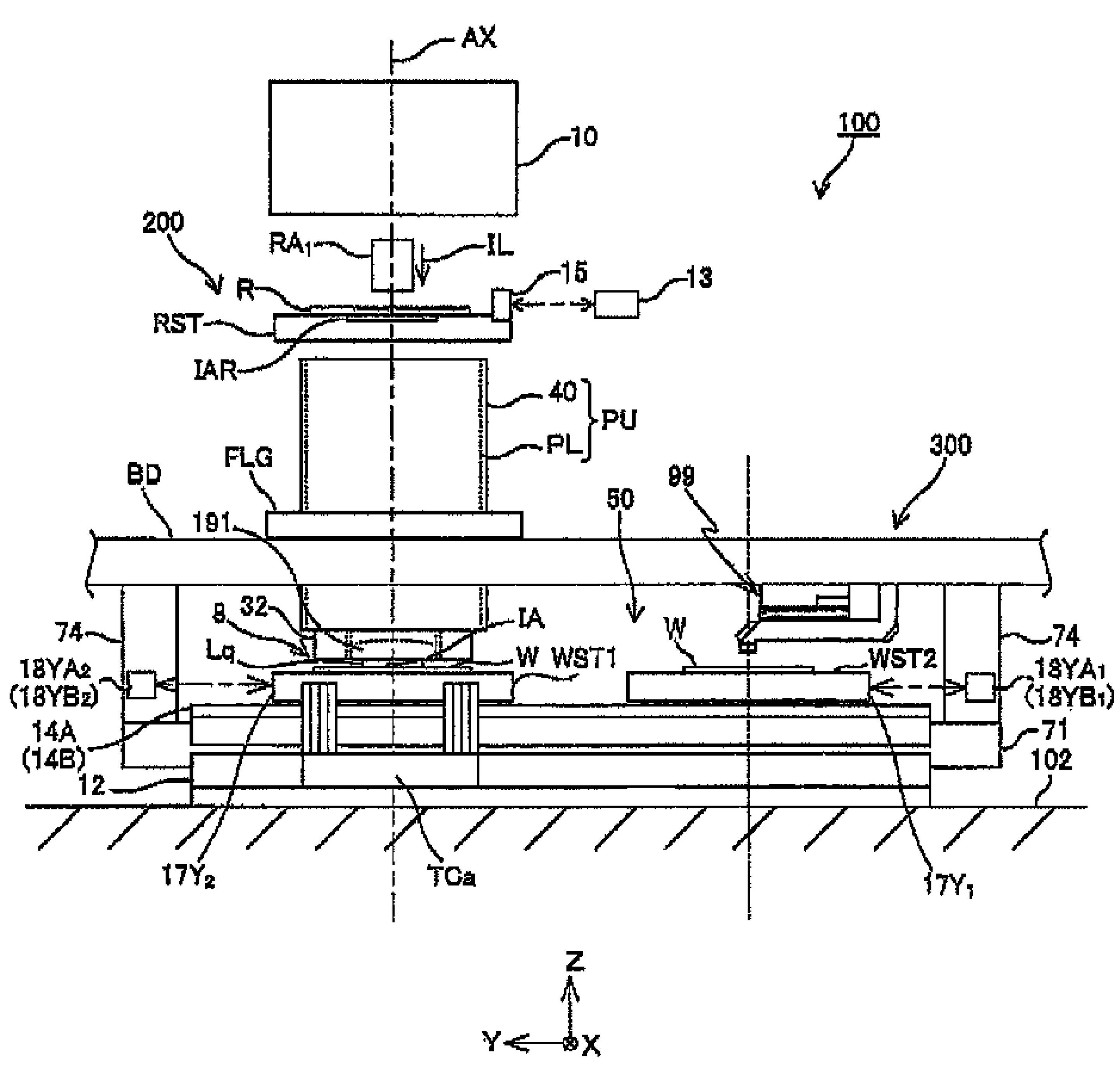
Primary Examiner — Hung Henry Nguyen
(74) *Attorney, Agent, or Firm* — Oliff & Berridge, PLC

(57) **ABSTRACT**

When a liquid immersion area (liquid) formed on a wafer stage is moved onto another wafer stage, a fine movement stage position measuring system measures positional information of the wafer stage, interferometers of a coarse movement stage position measuring system measure positional information of the another wafer stage, and different interferometers measure positional information of the wafer stage. Based on these measurement results, the wafer stage and the another wafer stage are made to be in proximity to each other and are driven while the scrum state is maintained, and thereby the liquid immersion area (liquid) formed on the wafer stage can be moved onto the another wafer stage.

19 Claims, 32 Drawing Sheets



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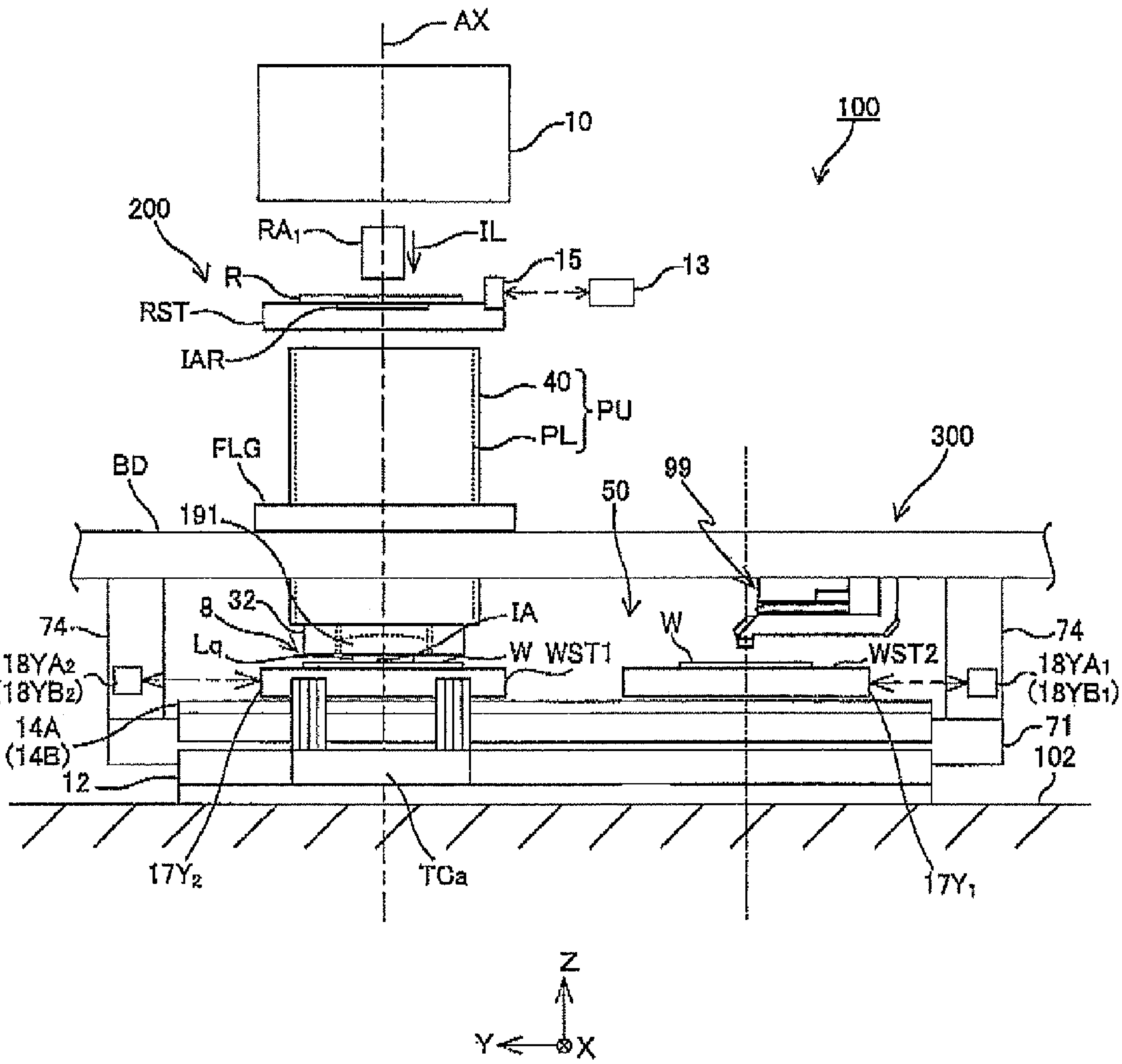
U.S. Appl. No. 12/818,276 in the name of Go Ichinose, filed Jun. 18, 2010.

U.S. Appl. No. 12/818,429 in the name of Go Ichinose, filed Jun. 18, 2010.

U.S. Appl. No. 12/818,386 in the name of Go Ichinose, filed Jun. 18, 2010.

* cited by examiner

Fig. 1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200
RA1
IL
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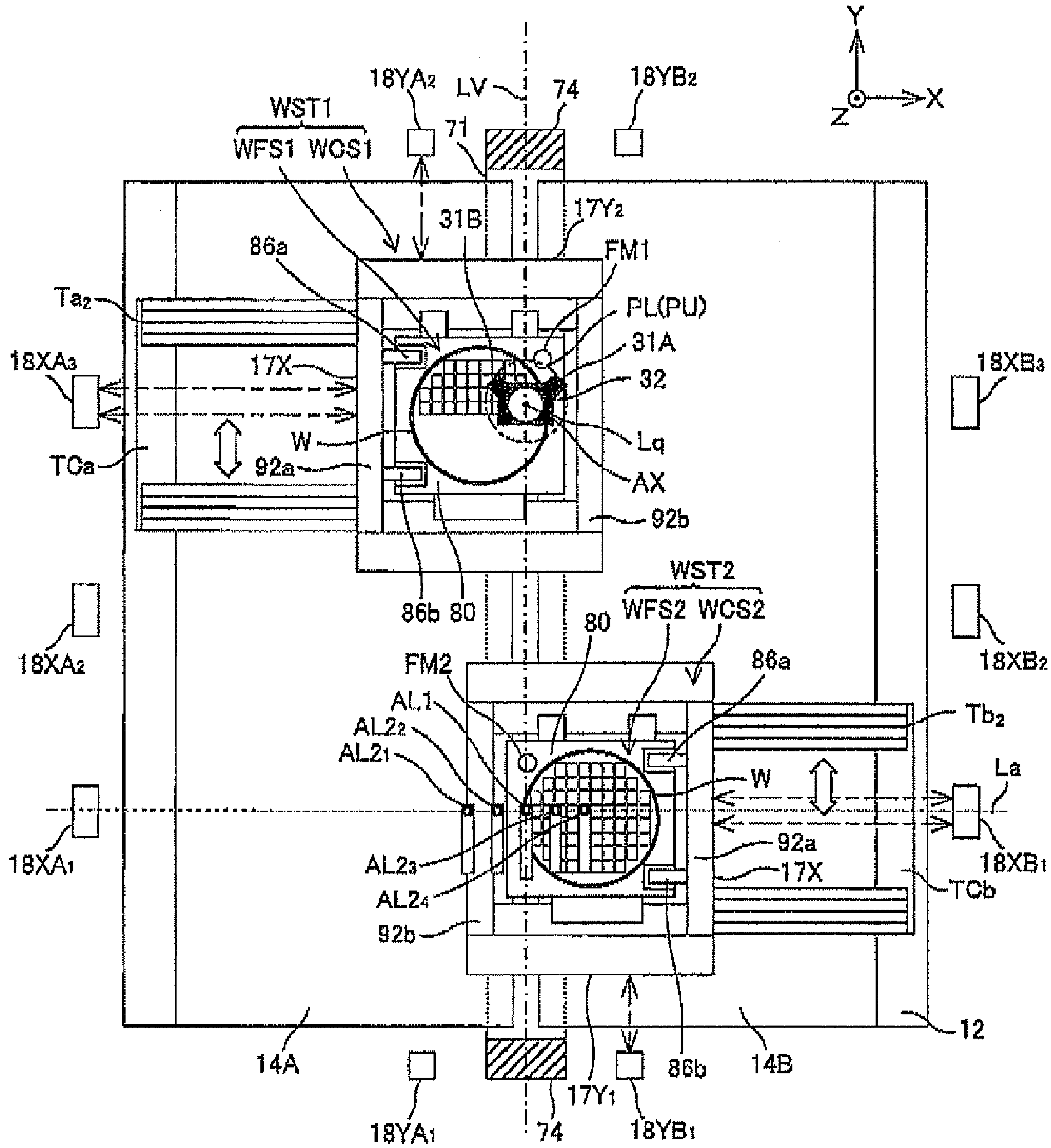
13
R
RST
IAR
40
PU
PL
FLG
300
BD
99
50
191
8
32
IA
74
W
Lq
W WST1
WST2
74
18YA2
(18YB2)
18YA1
(18YB1)
14A
(14B)
71
102
12
17Y2
TCa
17Y1
Z
Y
X

Fig. 2



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Z
X
LV
74
71
18YA2
18YB2
WST1
WFS1 WCS1
31B
17Y2
FM1
86a
PL(PU)
Ta2
31A
18XA3
17X
32
18XB3
W
Lq
TCa
92a
AX
92b
86b 80
WST2
18XA2
WFS2 WCS2
18XB2
80
86a
FM2
AL1
AL22
Tb2
AL21
W
La
18XA1
AL23
92a
18XB1
AL24
17X
TCb
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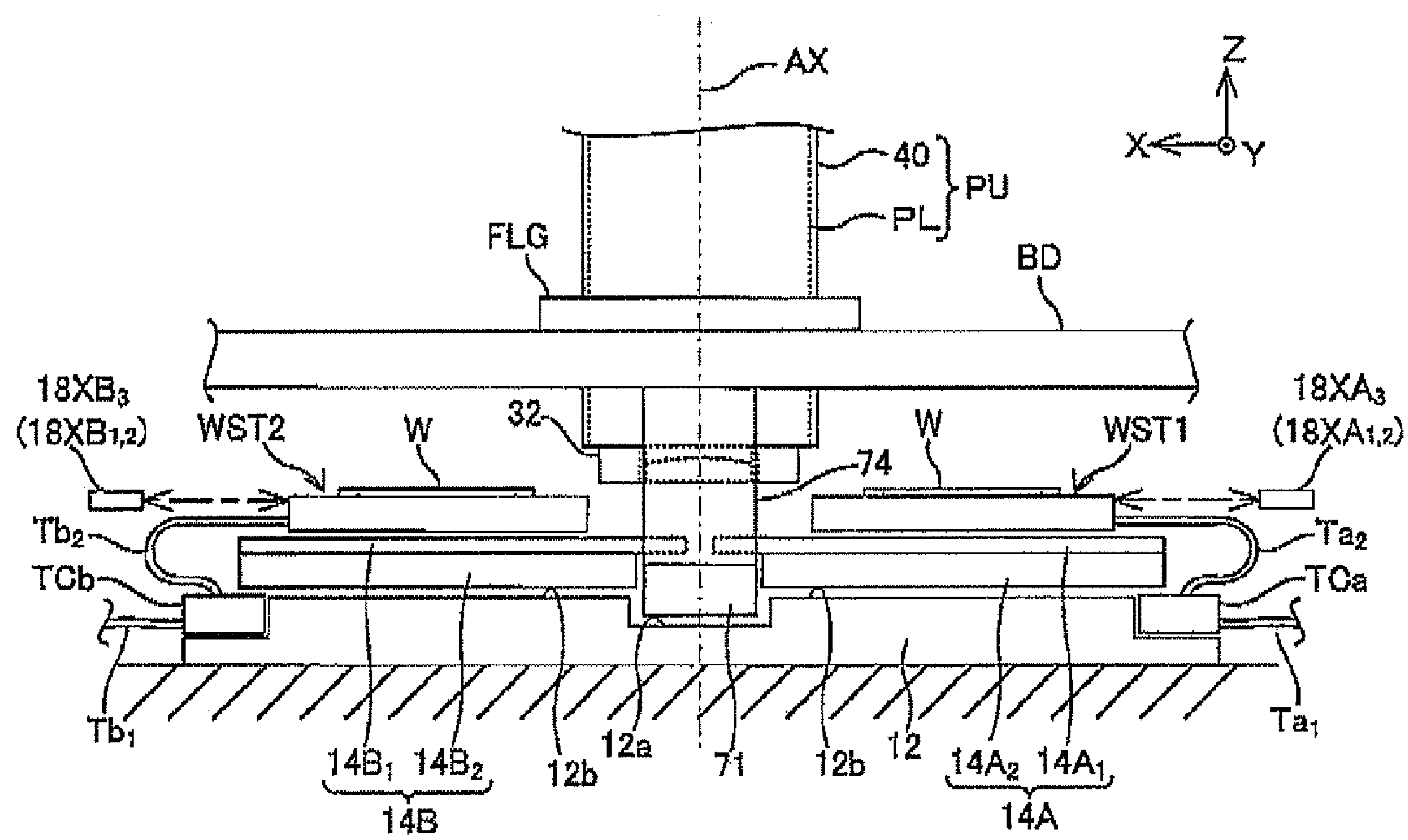
12
14A
86b
14B
17Y1
18YA1
74
18YB1

Fig. 3



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FLG
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18XA3
(18XA1,2)
Tb2
Ta2
TCb
TCa
Tb1
Ta1
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14B2
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12a
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12b
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14B
14A

Fig. 4A

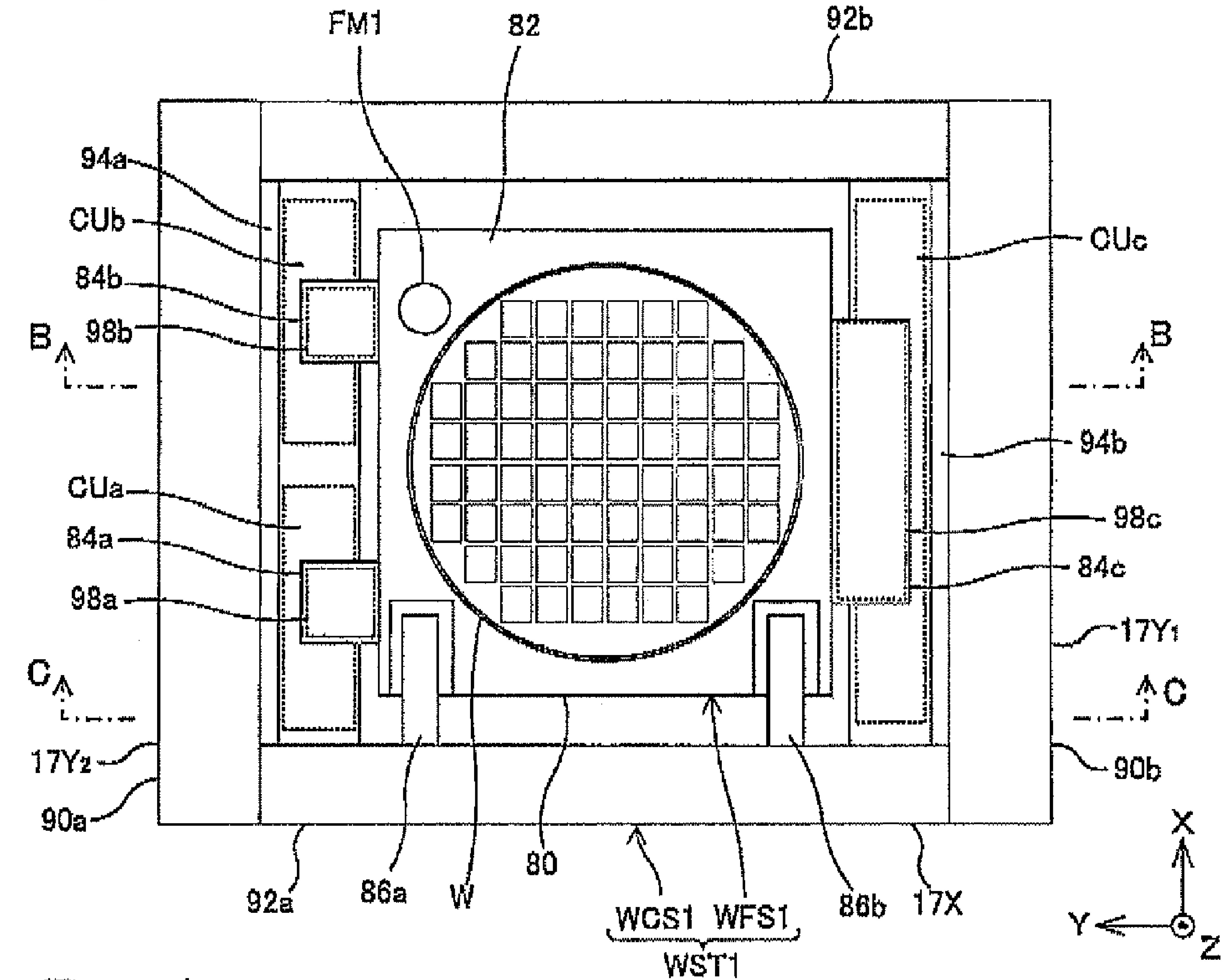


Fig. 4B

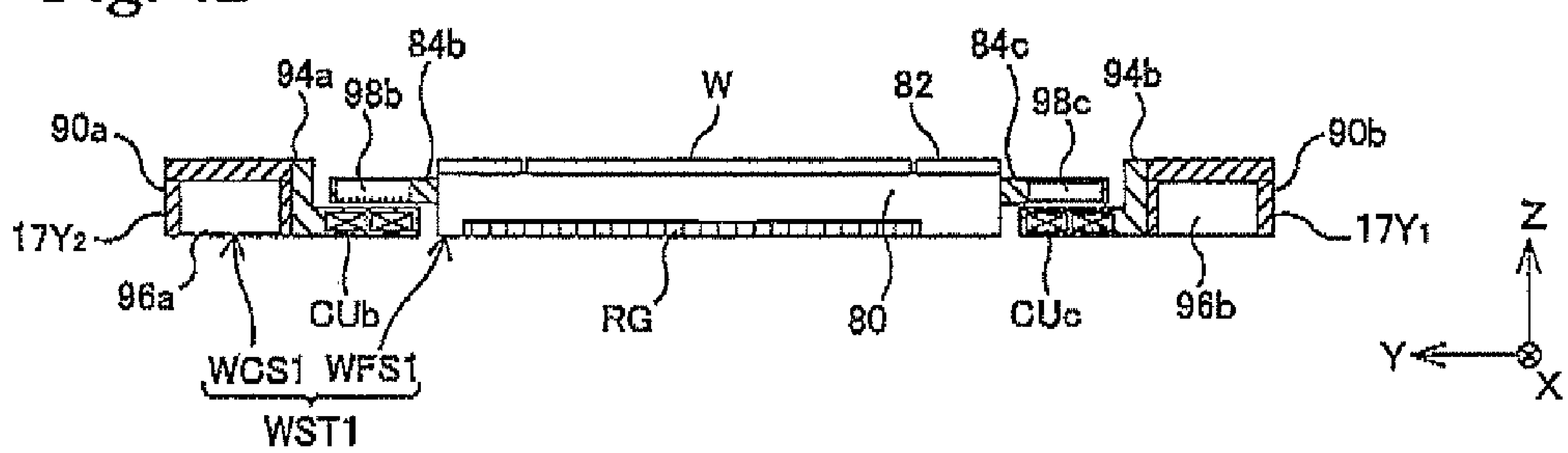


Fig. 4C

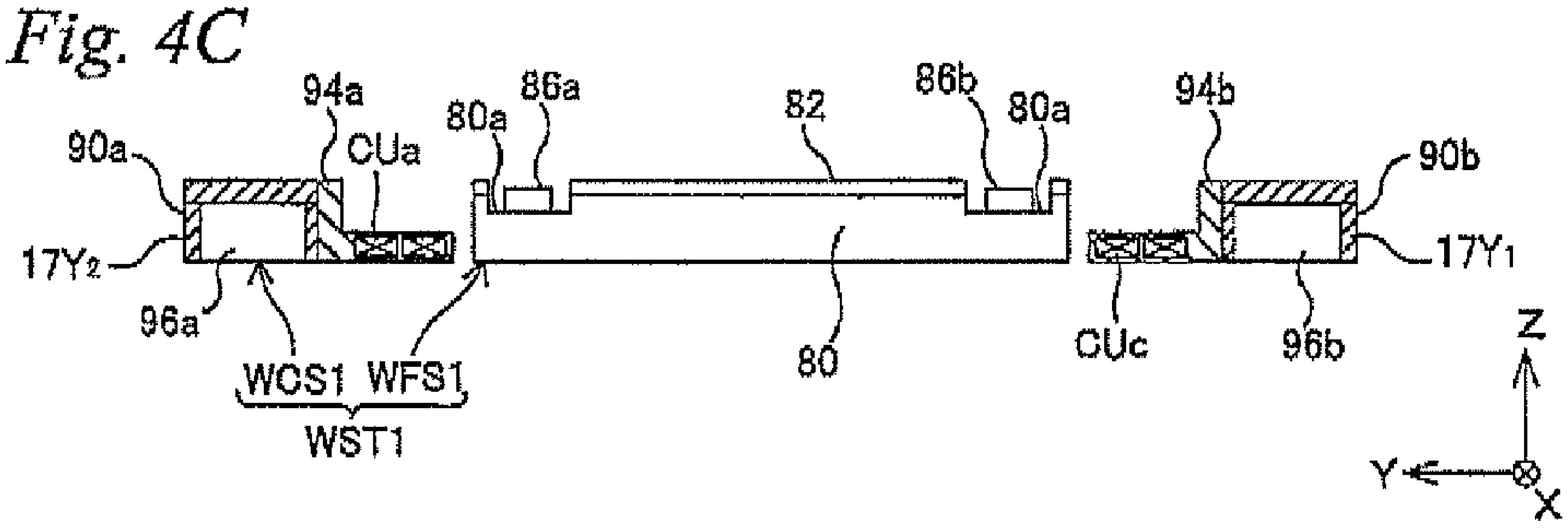
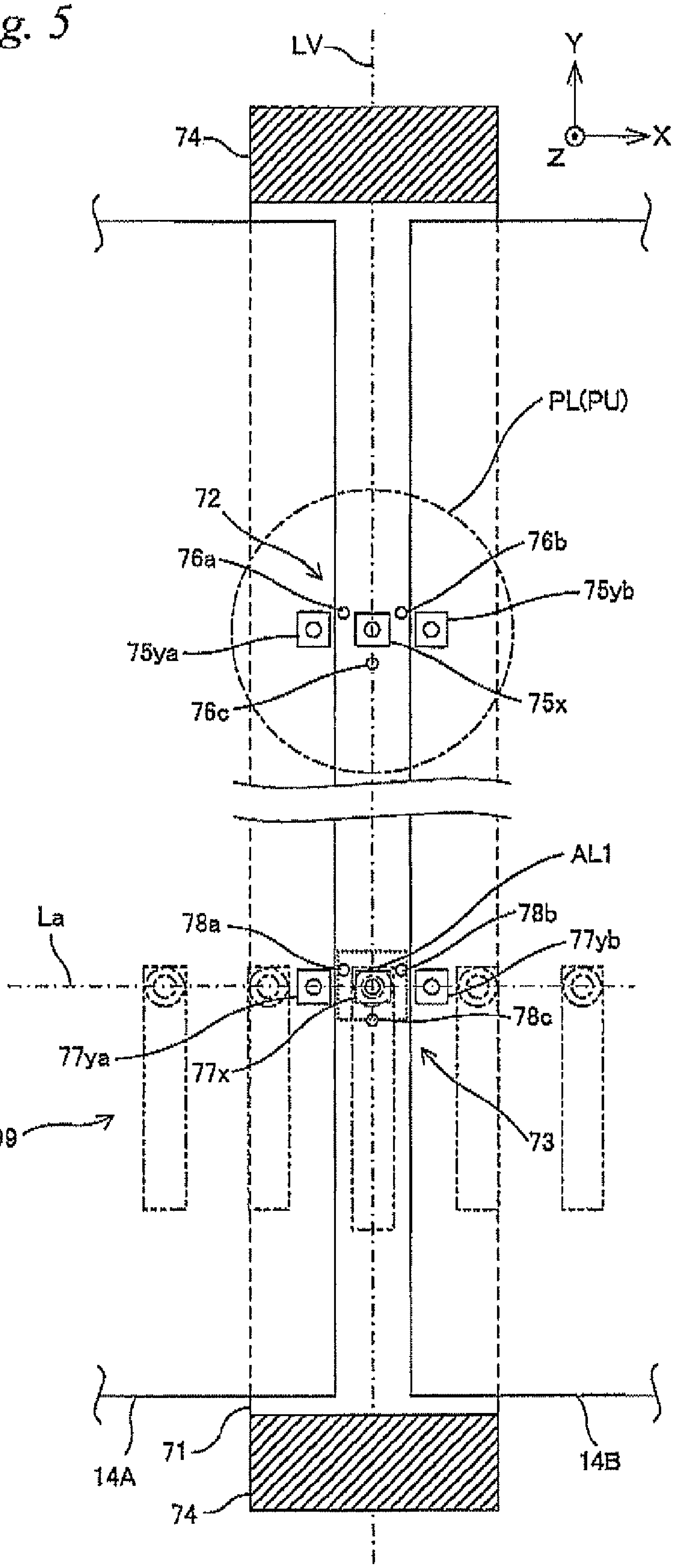


Fig. 5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75ya
75x
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78b
77yb
78c
77ya
77x
99
73
71
14A
14B
74

Fig. 6

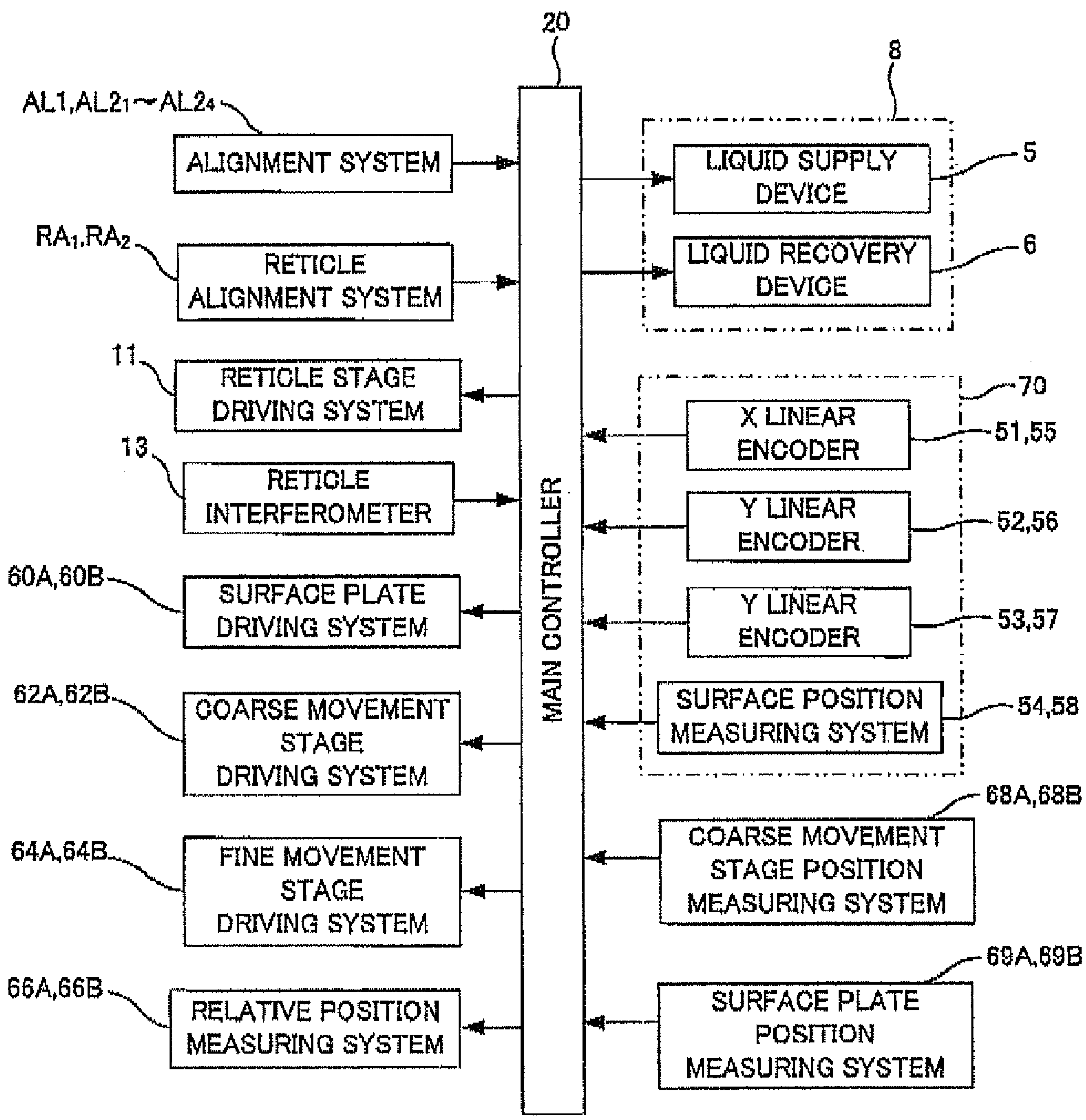
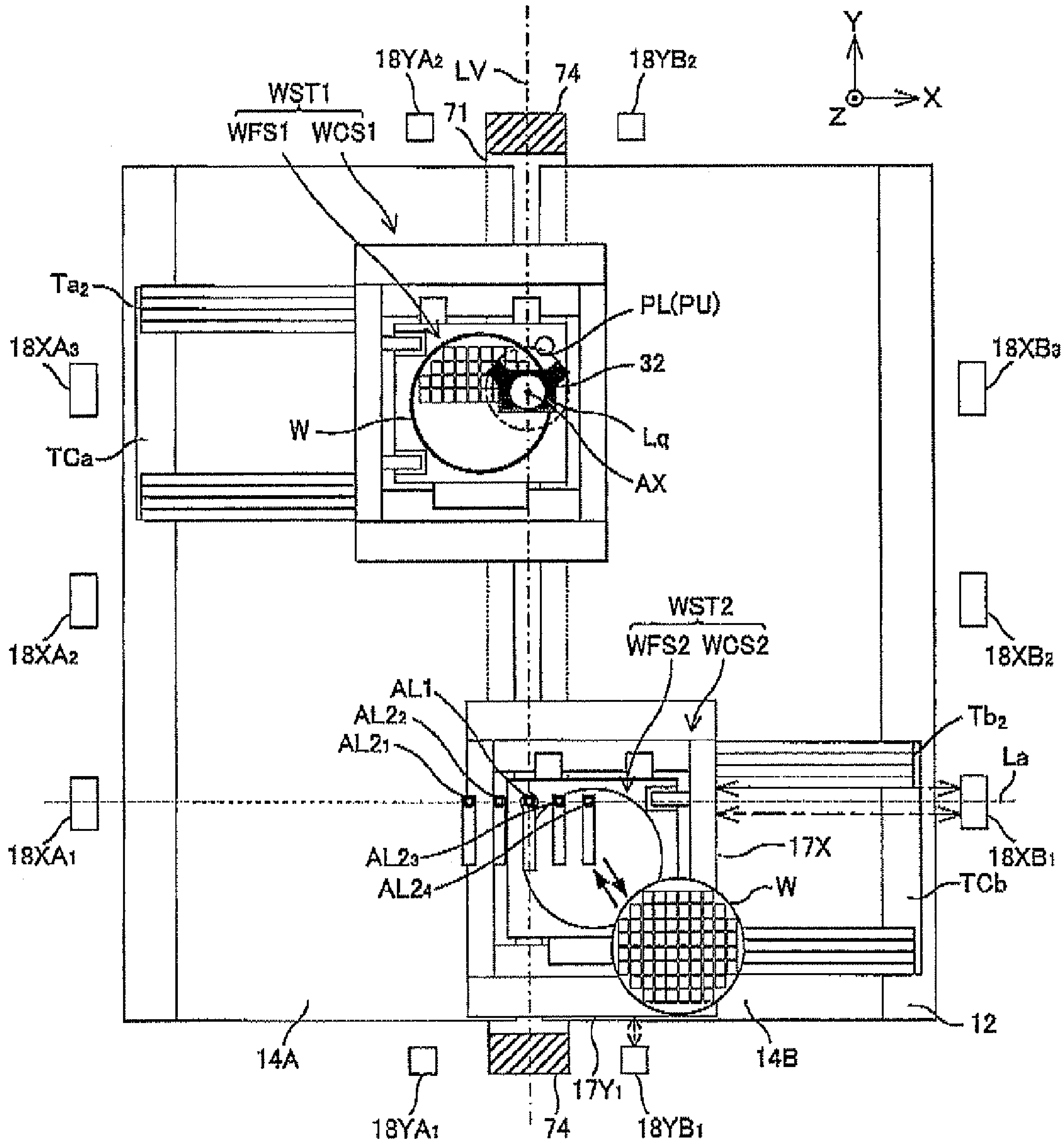

20
8
AL1,AL2₁~AL2₄
ALIGNMENT SYSTEM
LIQUID SUPPLY DEVICE
5
RA₁,RA₂
RETICLE ALIGNMENT SYSTEM
LIQUID RECOVERY DEVICE
6
11
RETICLE STAGE DRIVING SYSTEM
70
X LINEAR ENCODER
51,55
13
RETICLE INTERFEROMETER
Y LINEAR ENCODER
52,56
60A,60B
SURFACE PLATE DRIVING SYSTEM
Y LINEAR ENCODER
53,57
MAIN CONTROLLER
62A,62B
COARSE MOVEMENT STAGE DRIVING SYSTEM
SURFACE POSITION MEASURING SYSTEM
54,58
68A,68B
COARSE MOVEMENT STAGE POSITION MEASURING SYSTEM
64A,64B
FINE MOVEMENT STAGE DRIVING SYSTEM
69A,69B
66A,66B
RELATIVE POSITION MEASURING SYSTEM
SURFACE PLATE POSITION MEASURING SYSTEM

Fig. 7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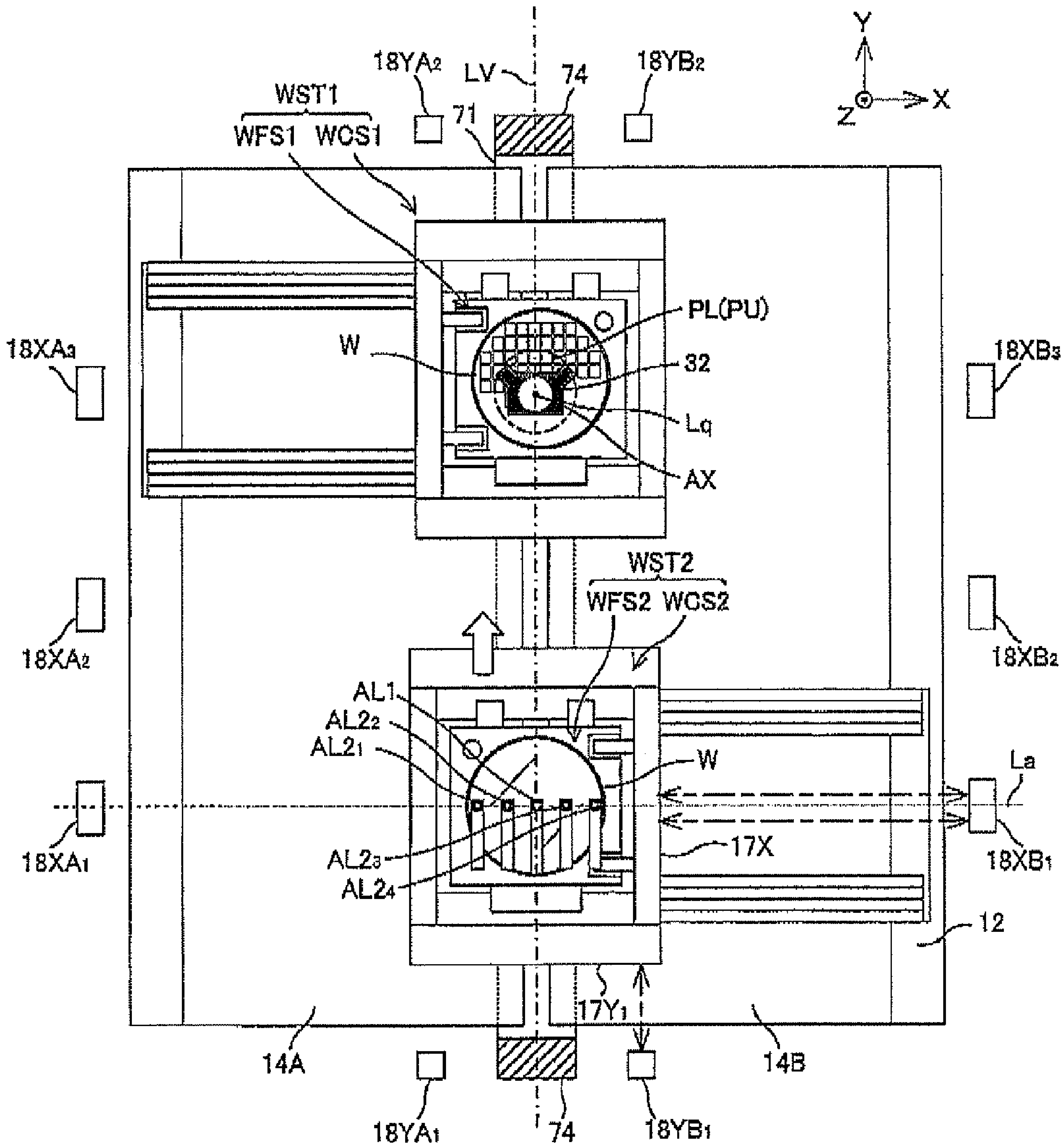
W
Lq
TCa
AX
18XA2
18XB2
WST2
WFS2
WCS2
AL1
AL22
Tb2
AL21
La
18XA1
18XB1
AL23
17X
AL24
W
TCb
12
14A
14B
17Y1
18YA1
74
18YB1

Fig. 8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PL(PU)
W
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18XB3
WST2
WFS2 WCS2
18XA2
18XB2
AL1
AL22
AL21
W
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AL24
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17Y1
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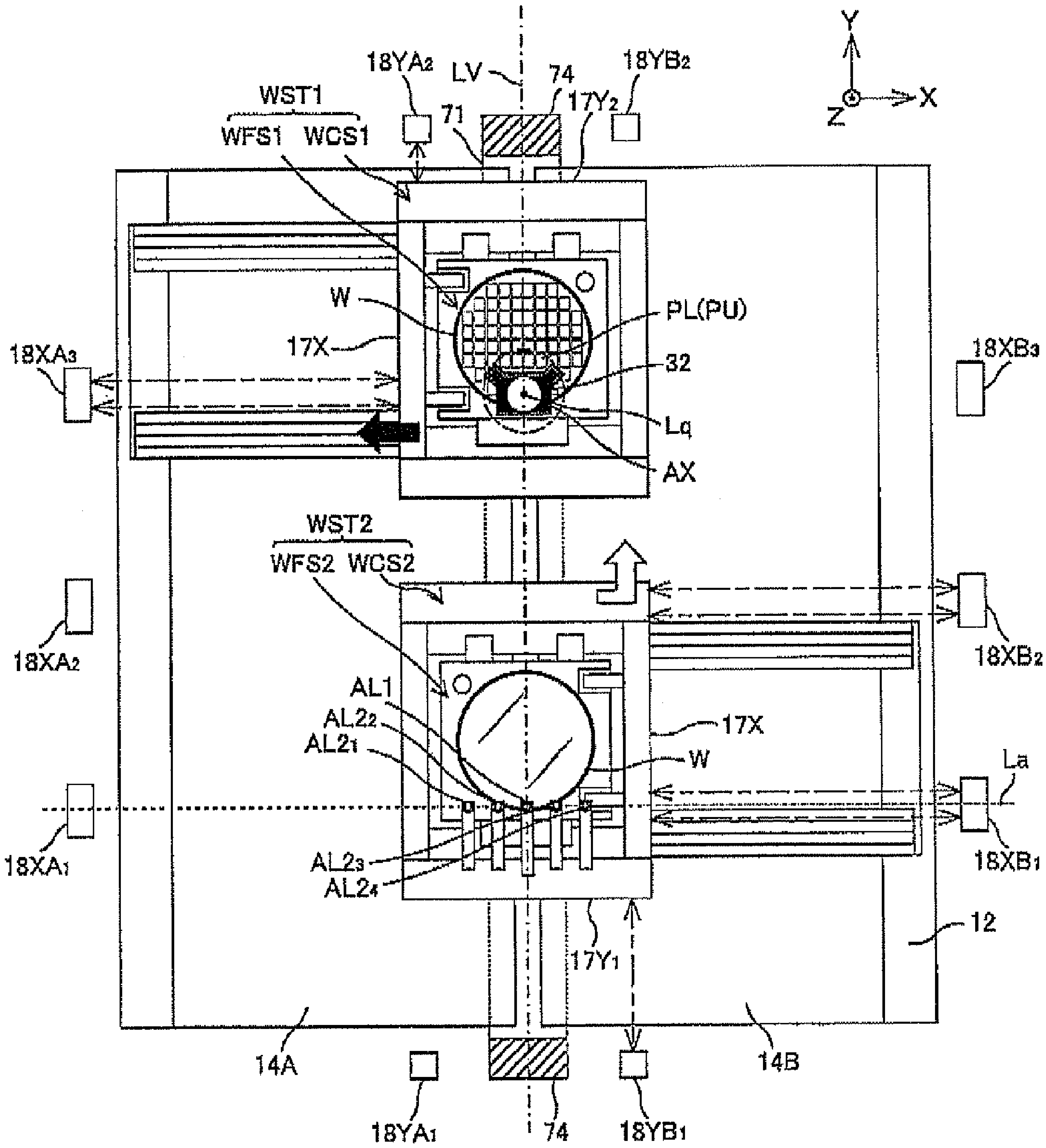
14B
18YA1
74
18YB1

Fig. 9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LV
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18YB2
WST1
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17Y2
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18XA3
18XB3
32
Lq
AX
WST2
WFS2 WCS2
18XA2
18XB2
AL1
AL22
AL21
17X
W
La
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AL23
AL24
18XB1
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17Y1
14A
14B
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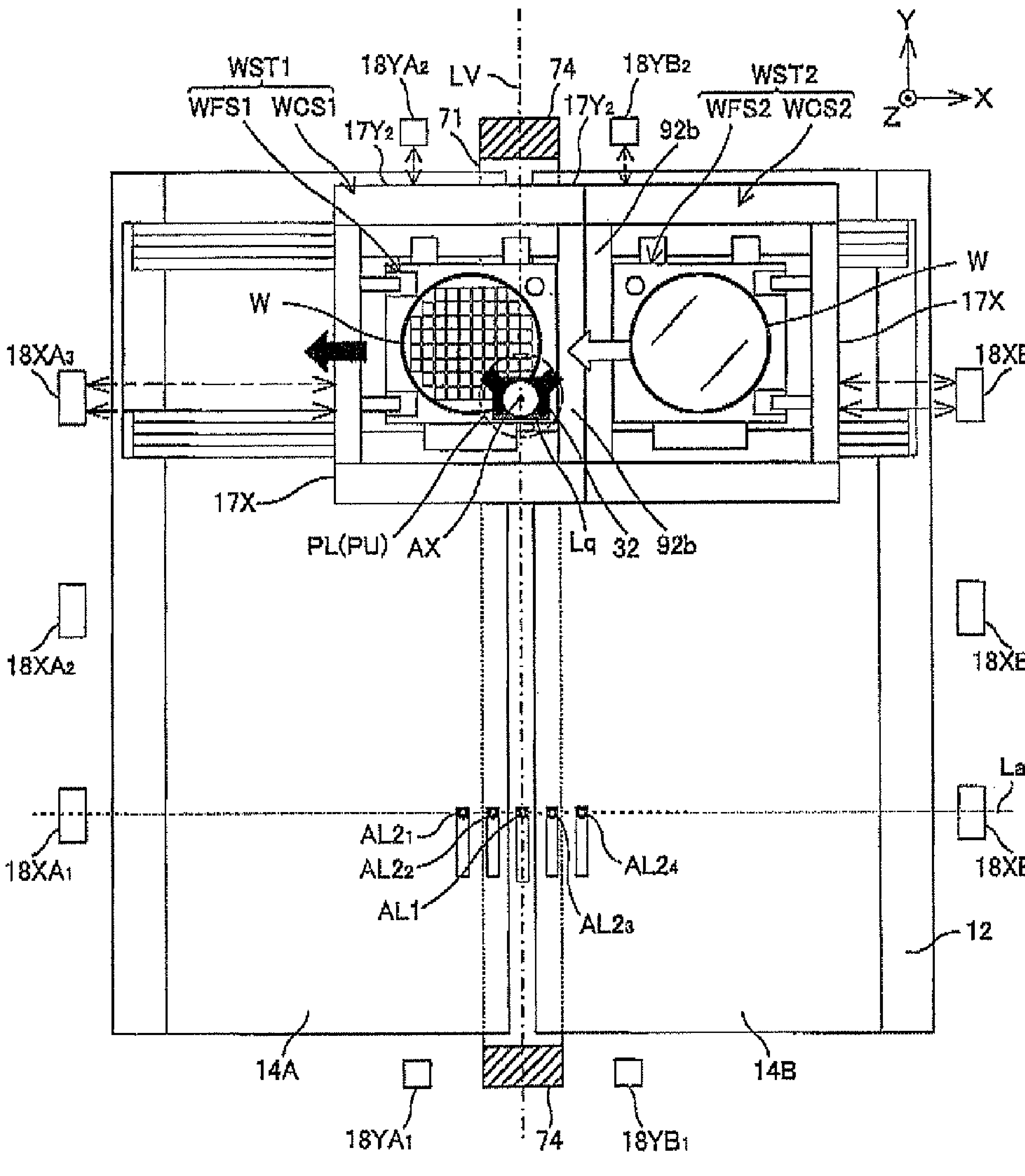
74
18YB1

Fig. 10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17Y2
92b
W
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17X
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18XB3
17X
PL(PU)
AX
Lq
32
92b
18XA2
18XB2
La
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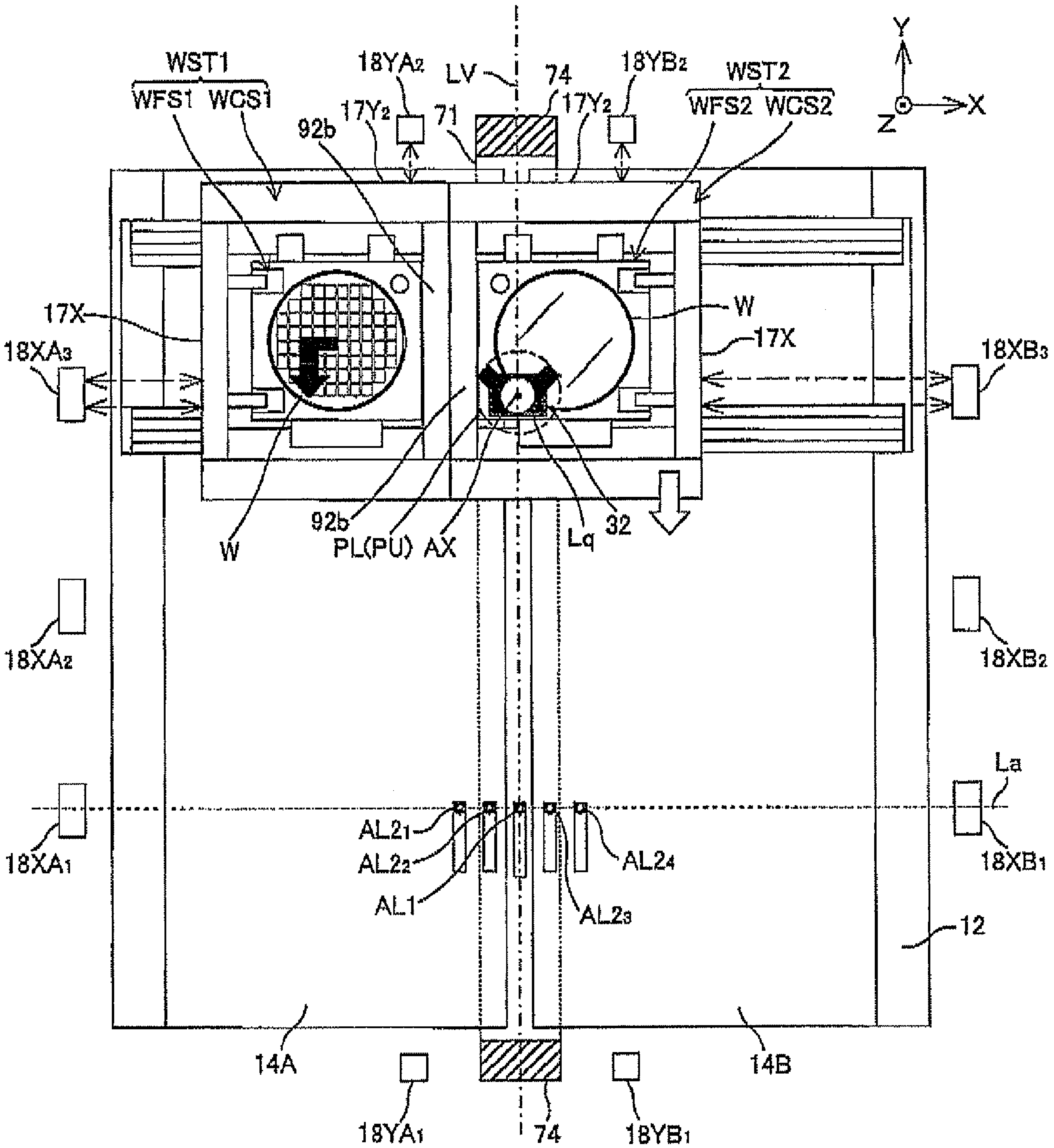
14A
14B
18YA1
74
18YB1

Fig. 11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Z
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17Y2
17X
18XA3
W
17X
18XB3
92b
PL(PU) AX
Lq
32
W
18XA2
18XB2
La
AL21
AL22
AL1
AL23
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18XB1
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14A
14B
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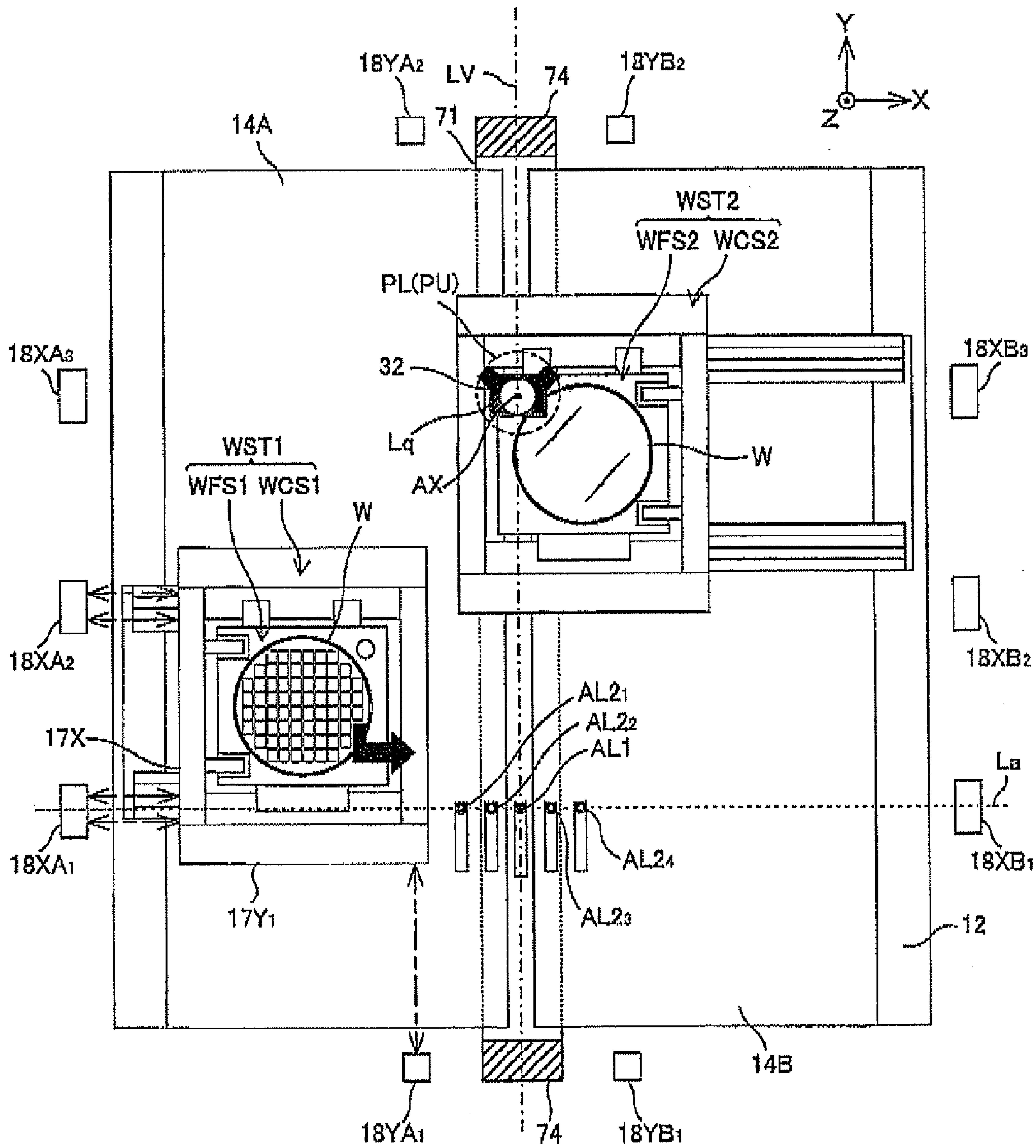
74
18YB1

Fig. 12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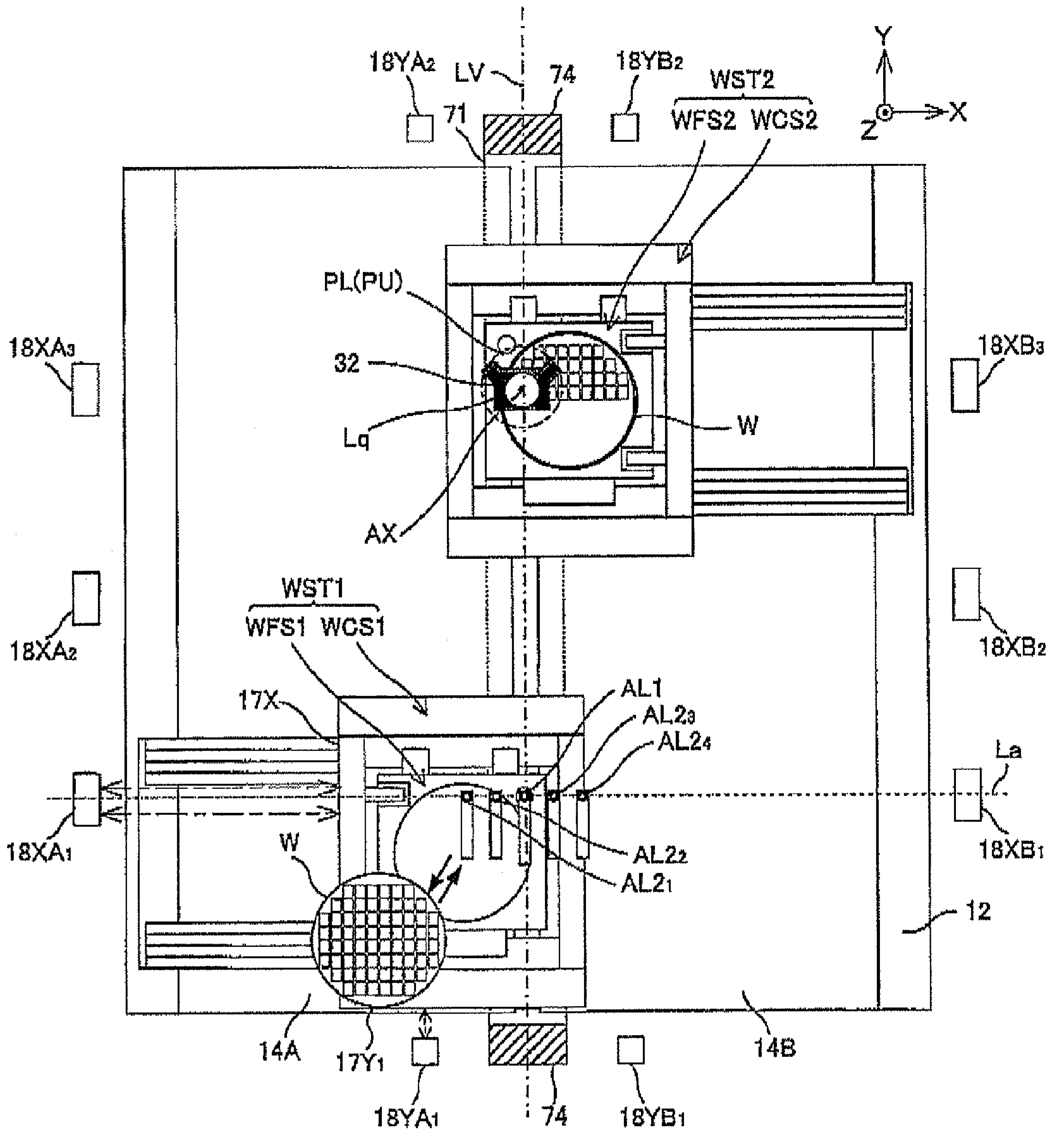
74
18YB1

Fig. 13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W
AX
18XA2
WST1
WFS1 WCS1
18XB2
17X
AL1
AL23
AL24
La
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18XB1
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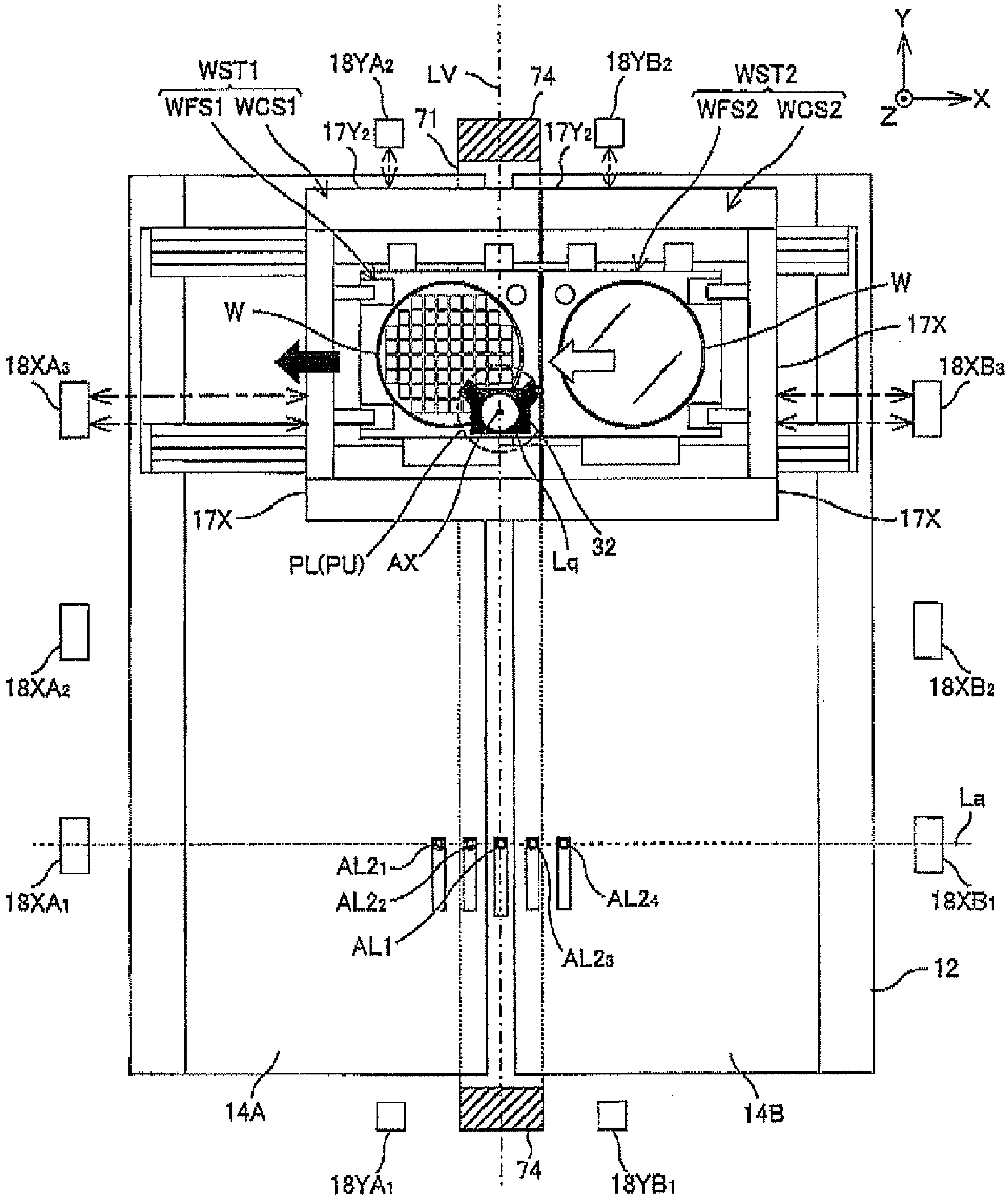
14A
17Y1
14B
18YA1
74
18YB1

Fig. 14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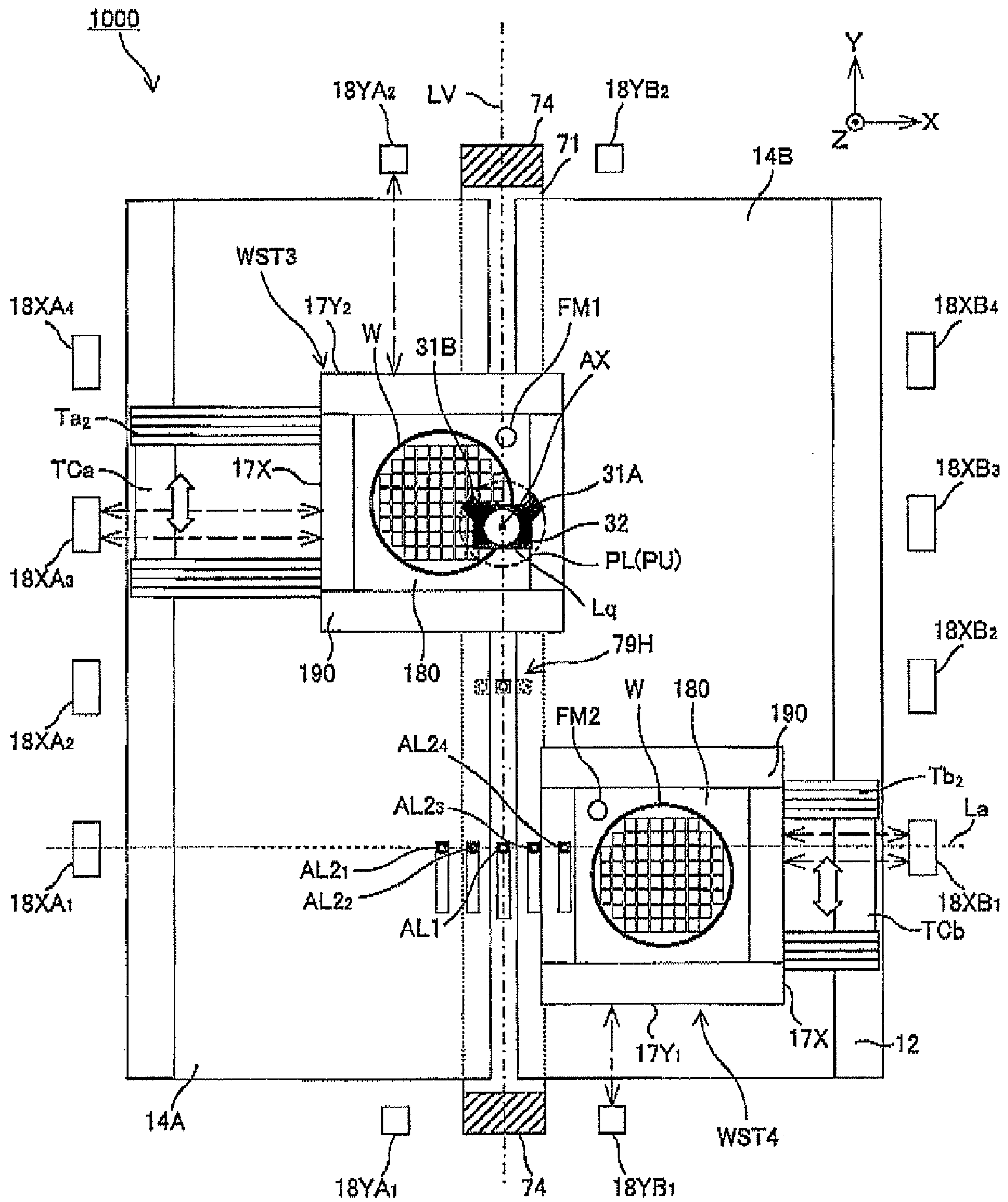
Z
X
W
W
17X
18XA3
18XB3
17X
17X
PL(PU)
AX
Lq
32
18XA2
18XB2
La
AL21
AL22
AL1
AL24
AL23
18XA1
18XB1
12
14A
14B
18YA1
74
18YB1

Fig. 15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LV
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18YB2
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X
Z
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14B
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17Y2
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31B
FM1
AX
18XB4
Ta2
TCa
17X
31A
18XB3
32
PL(PU)
18XA3
Lq
18XB2
79H
190
180
18XA2
W
180
FM2
190
AL24
Tb2
AL23
La
AL21
AL22
AL1
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TCb
17X
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17Y1
14A
WST4
18YA1
74
18YB1

Fig. 16A

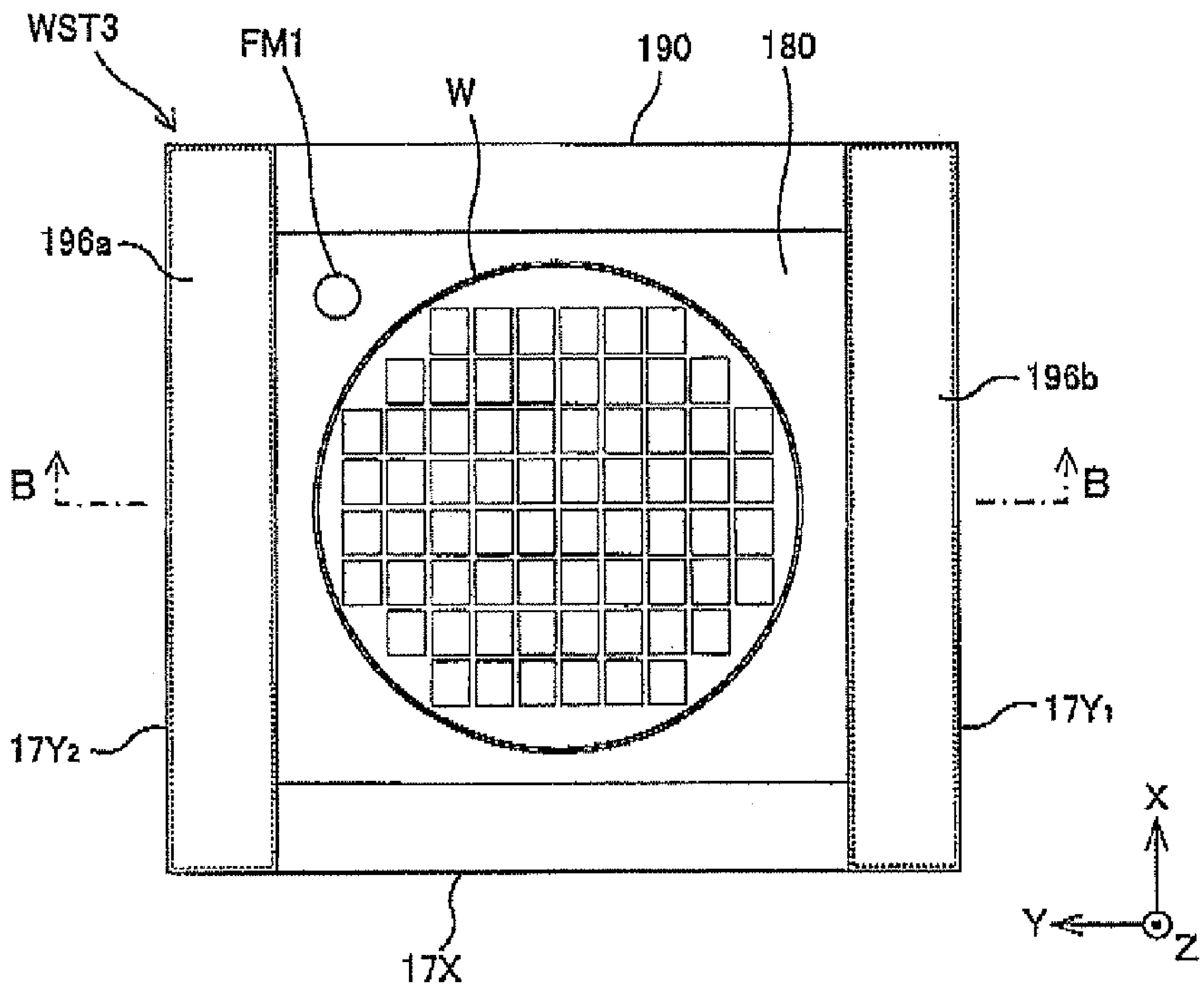


Fig. 16B

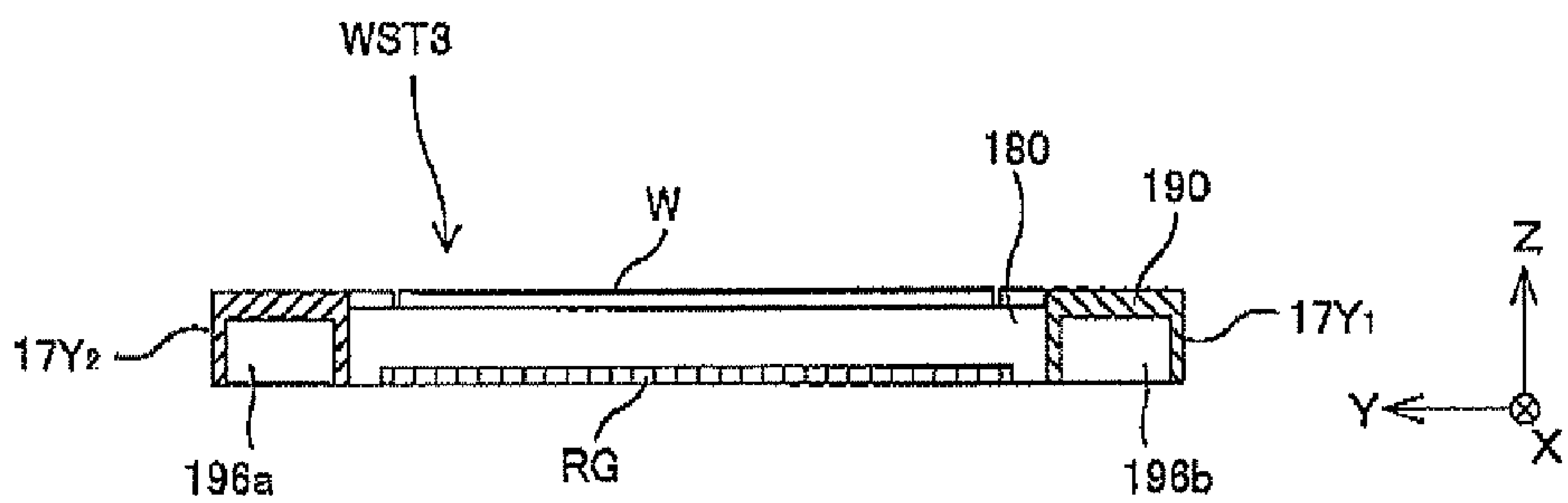
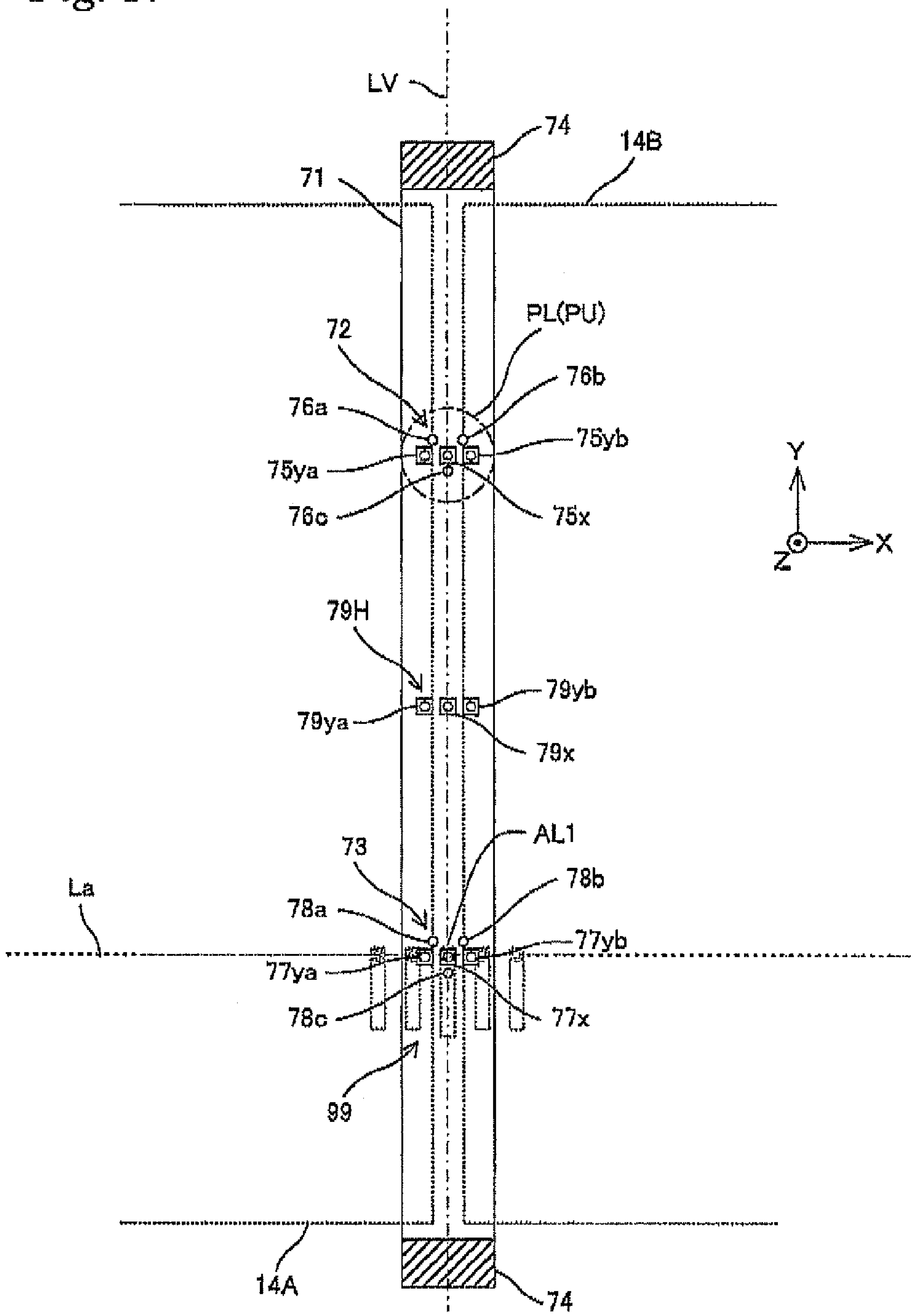


Fig. 17


LV
74
14B
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72
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76a
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75x
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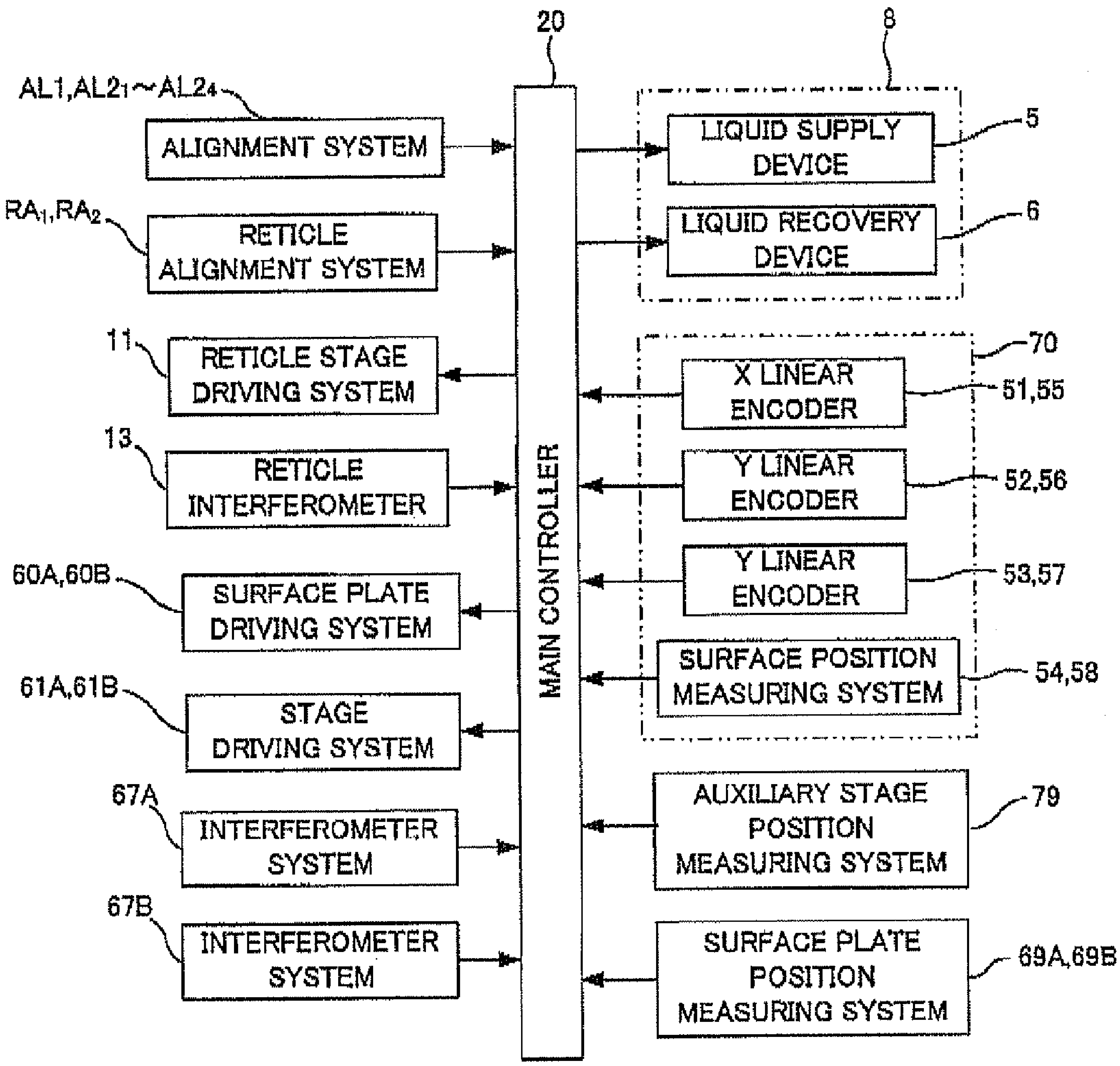
Z
X
79H
79yb
79ya
79x
73
AL1
78b
La
78a
77yb
77ya
78c
77x
99
14A
74

Fig. 18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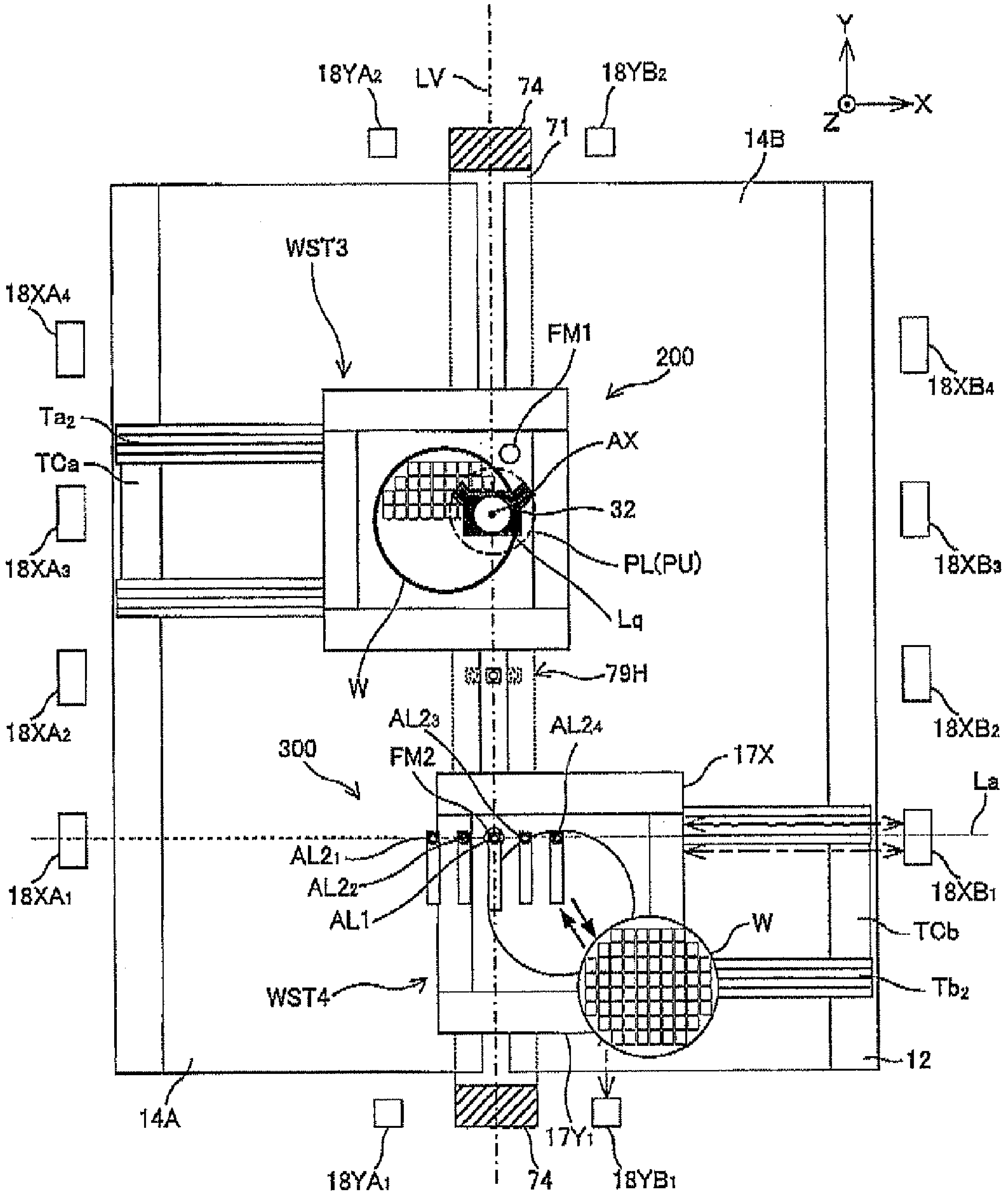
8
AL1,AL2₁~AL2₄
ALIGNMENT SYSTEM
LIQUID SUPPLY DEVICE
5
RA₁,RA₂
RETICLE ALIGNMENT SYSTEM
LIQUID RECOVERY DEVICE
6
11
RETICLE STAGE DRIVING SYSTEM
70
X LINEAR ENCODER
51,55
13
RETICLE INTERFEROMETER
Y LINEAR ENCODER
52,56
60A,60B
SURFACE PLATE DRIVING SYSTEM
Y LINEAR ENCODER
53,57
MAIN CONTROLLER
SURFACE POSITION MEASURING SYSTEM
54,58
61A,61B
STAGE DRIVING SYSTEM
67A
INTERFEROMETER SYSTEM
AUXILIARY STAGE POSITION MEASURING SYSTEM
79
67B
INTERFEROMETER SYSTEM
SURFACE PLATE POSITION MEASURING SYSTEM
69A,69B

Fig. 19



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AX
TCa
32
18XA3
PL(PU)
18XB3
Lq
W
79H
18XA2
18XB2
AL23
AL24
300
FM2
17X
La
AL21
AL22
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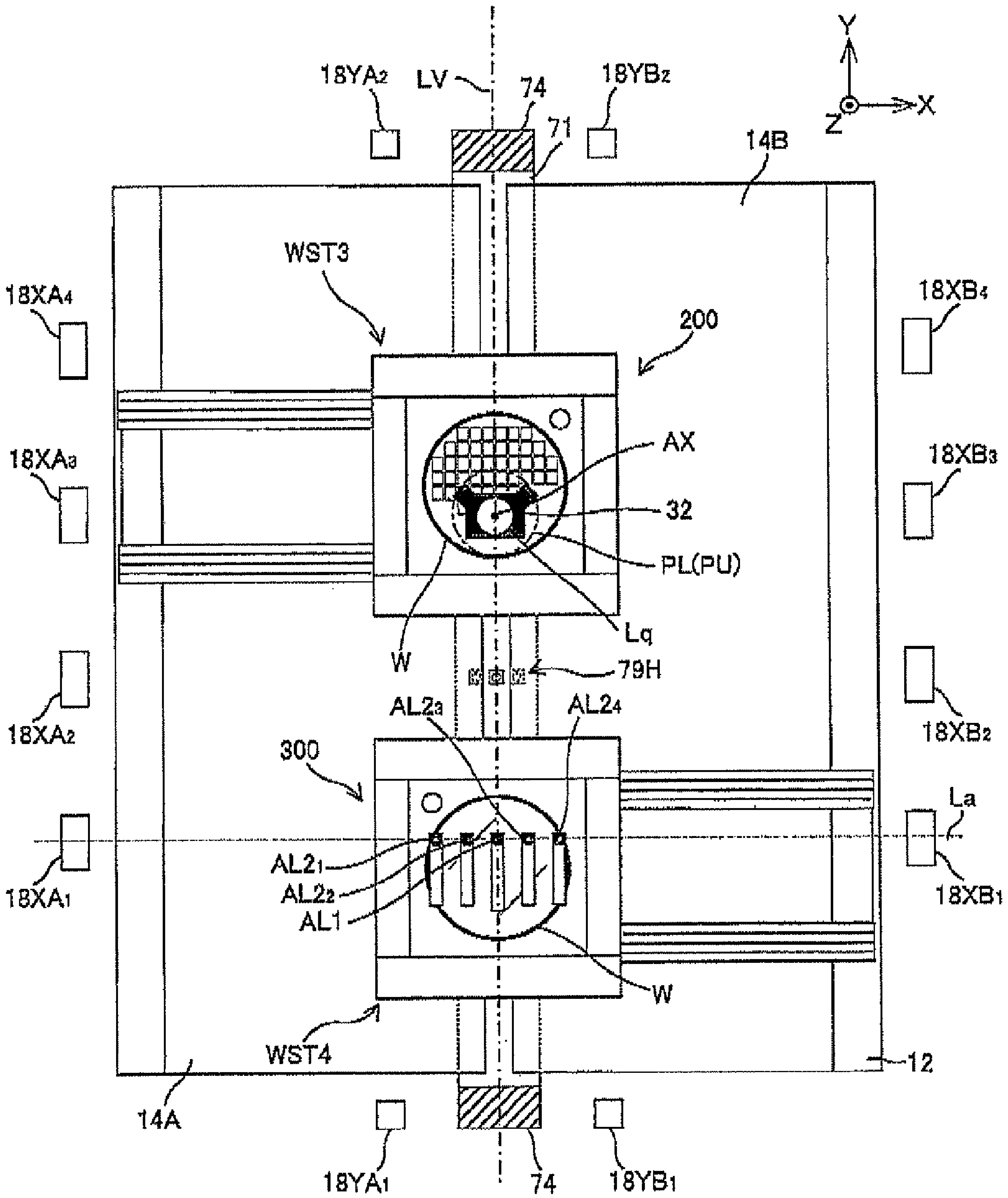
AL1
W
TCb
WST4
Tb2
12
14A
17Y1
18YA1
74
18YB1

Fig. 20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32
PL(PU)
Lq
W
79H
18XA2
AL23
AL24
18XB2
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WST4
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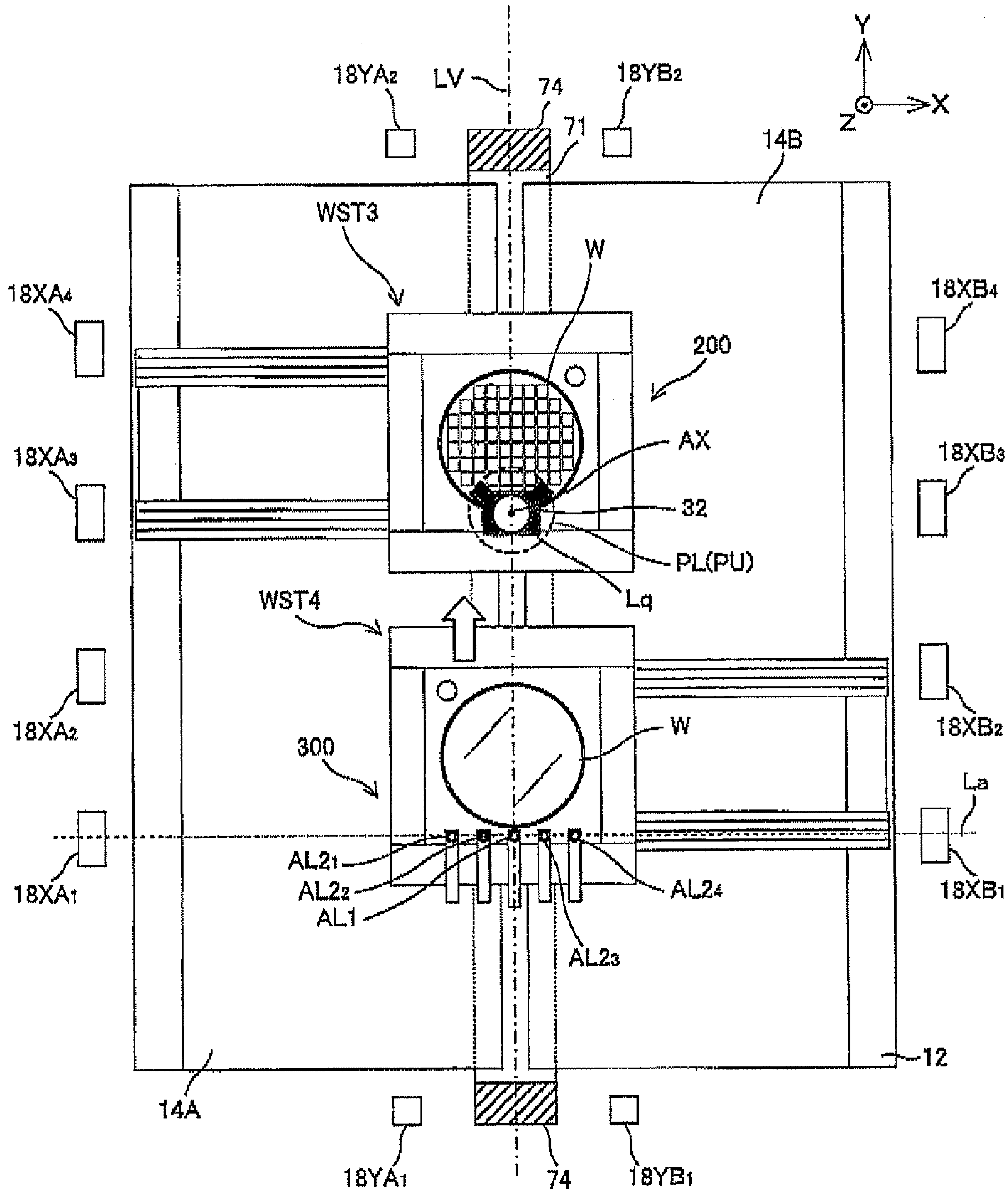
14A
18YA1
74
18YB1

Fig. 21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18XB3
32
PL(PU)
Lq
WST4
18XA2
18XB2
W
300
La
AL21
AL22
AL1
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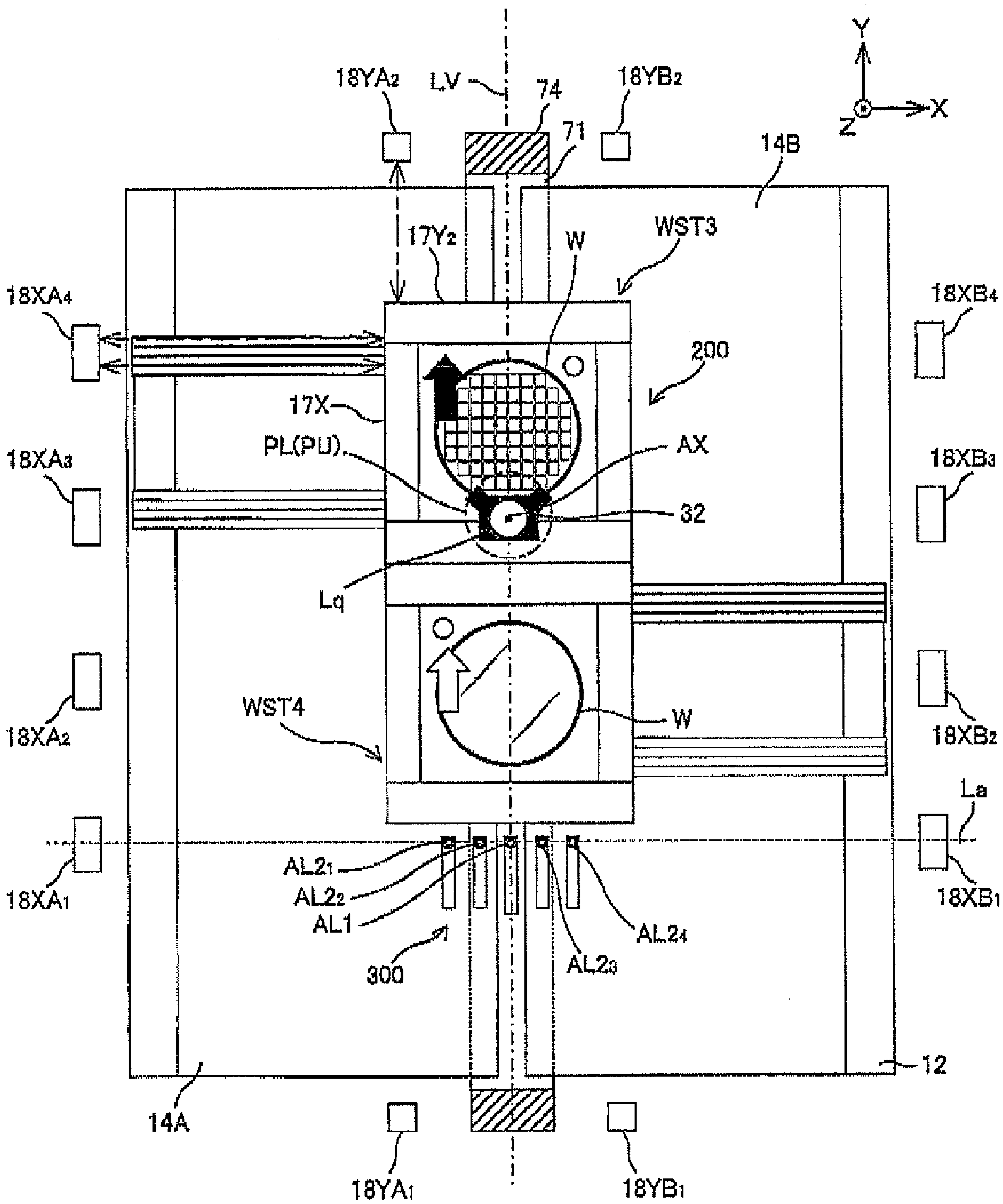
18XA1
18XB1
AL23
12
14A
18YA1
74
18YB1

Fig. 22



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18YB2
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14B
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18XA4
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17X
PL(PU)
AX
18XA3
18XB3
32
Lq
WST4
W
18XA2
18XB2
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300
AL23
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14A
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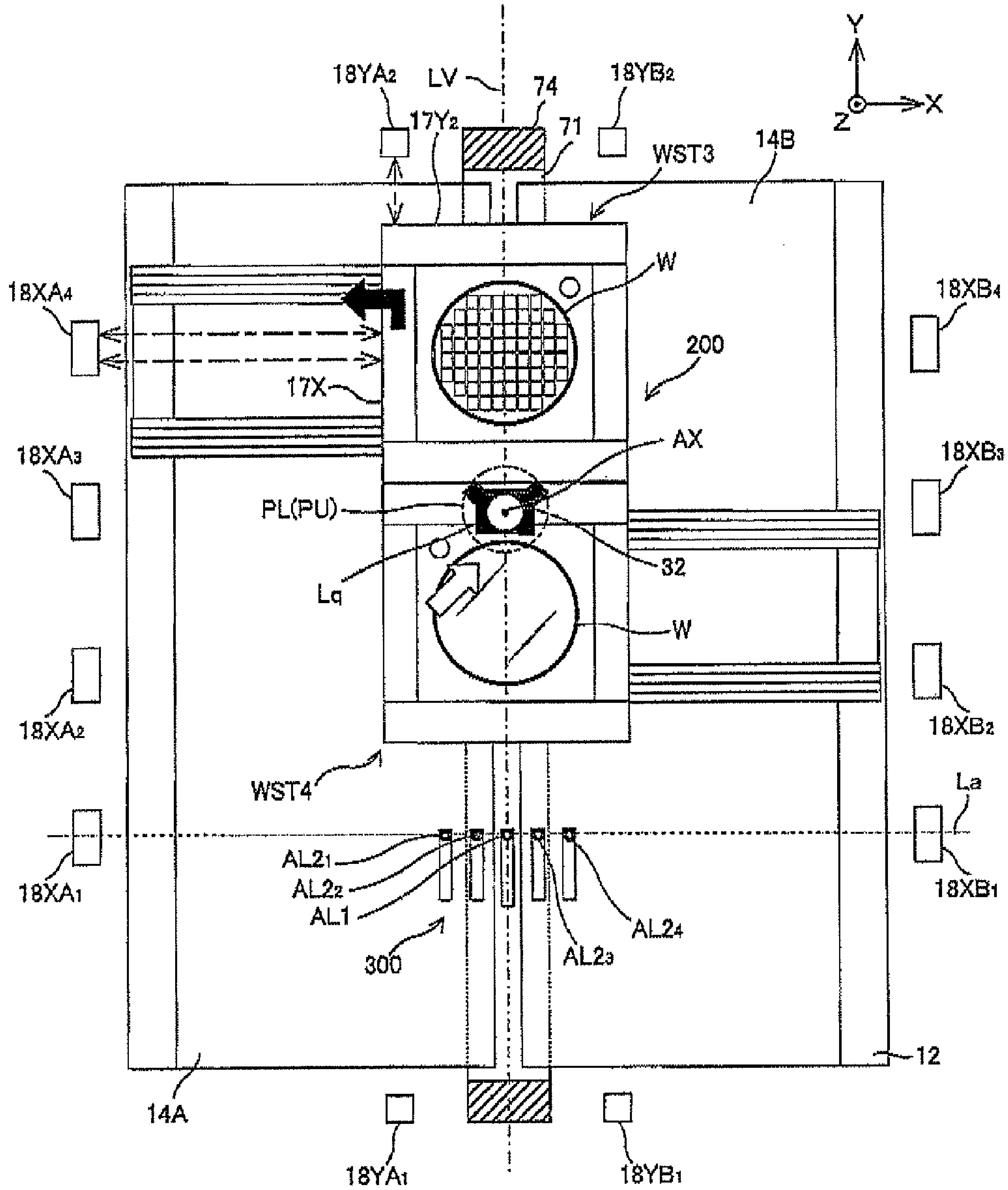
18YB1

Fig. 23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AX
18XA3
18XB3
PL(PU)
32
Lq
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18XB2
WST4
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AL23
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14A
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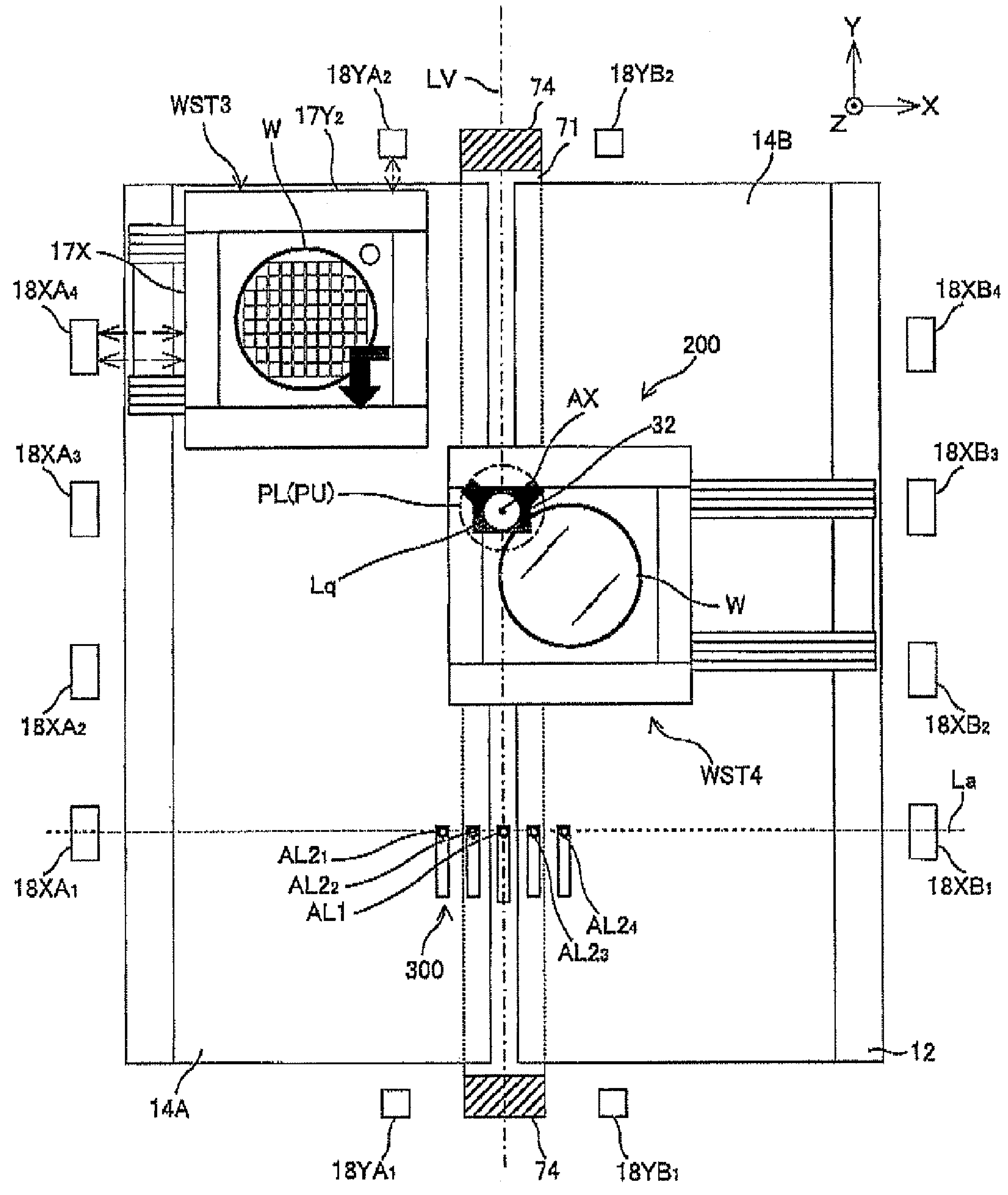
18YB1

Fig. 24



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18YB2
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18XA1
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Fig. 25

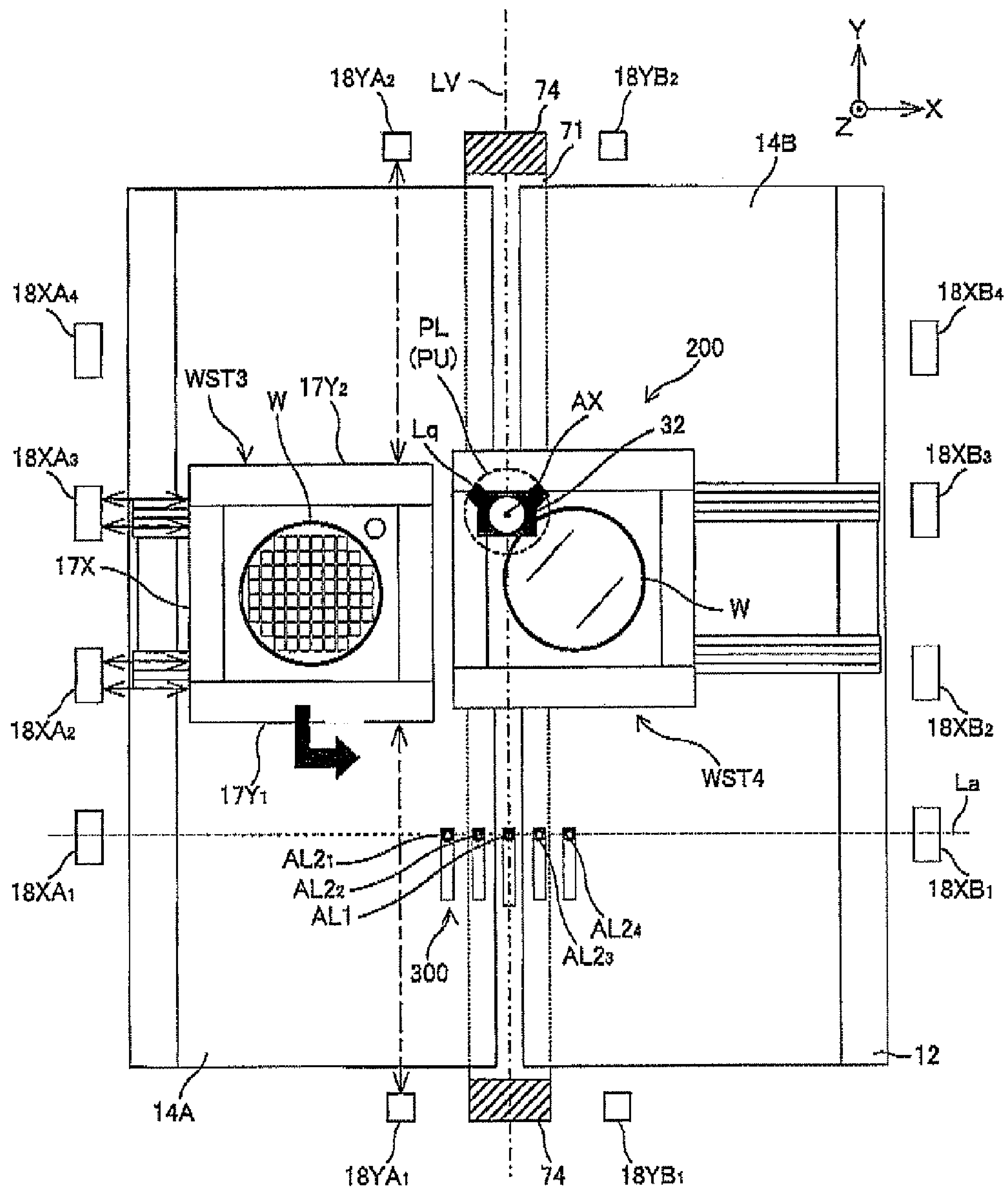

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Fig. 26

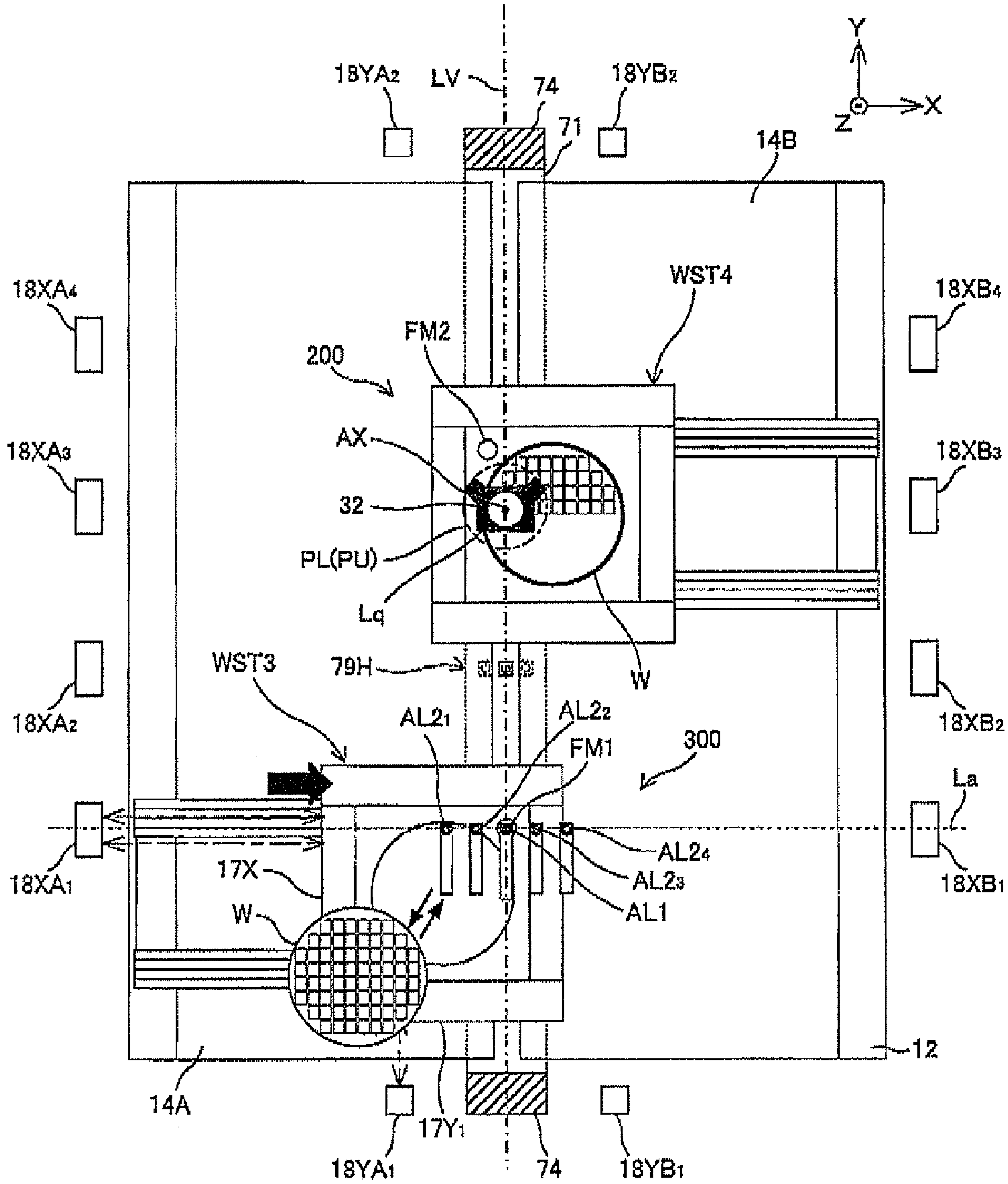
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Fig. 27

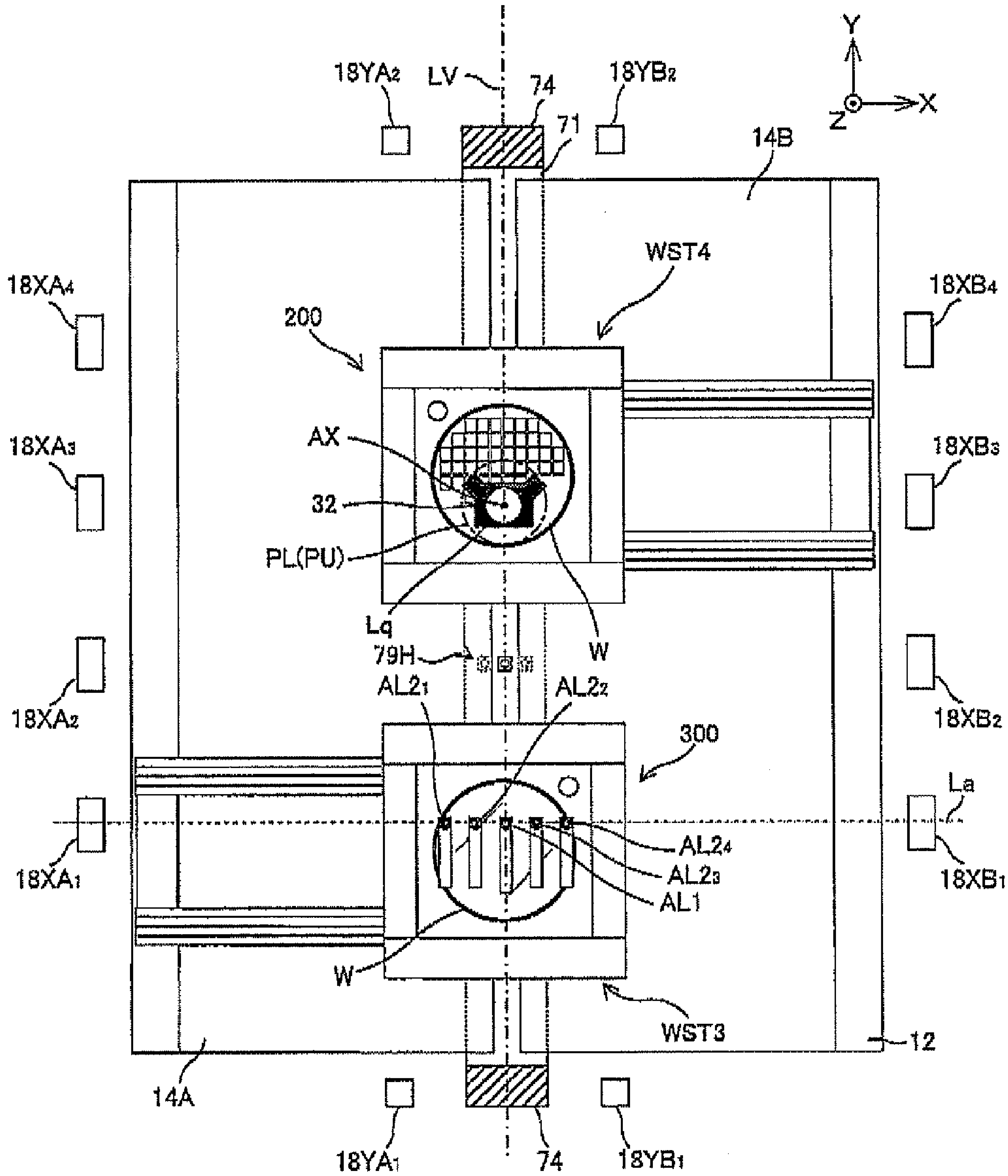

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Fig. 28

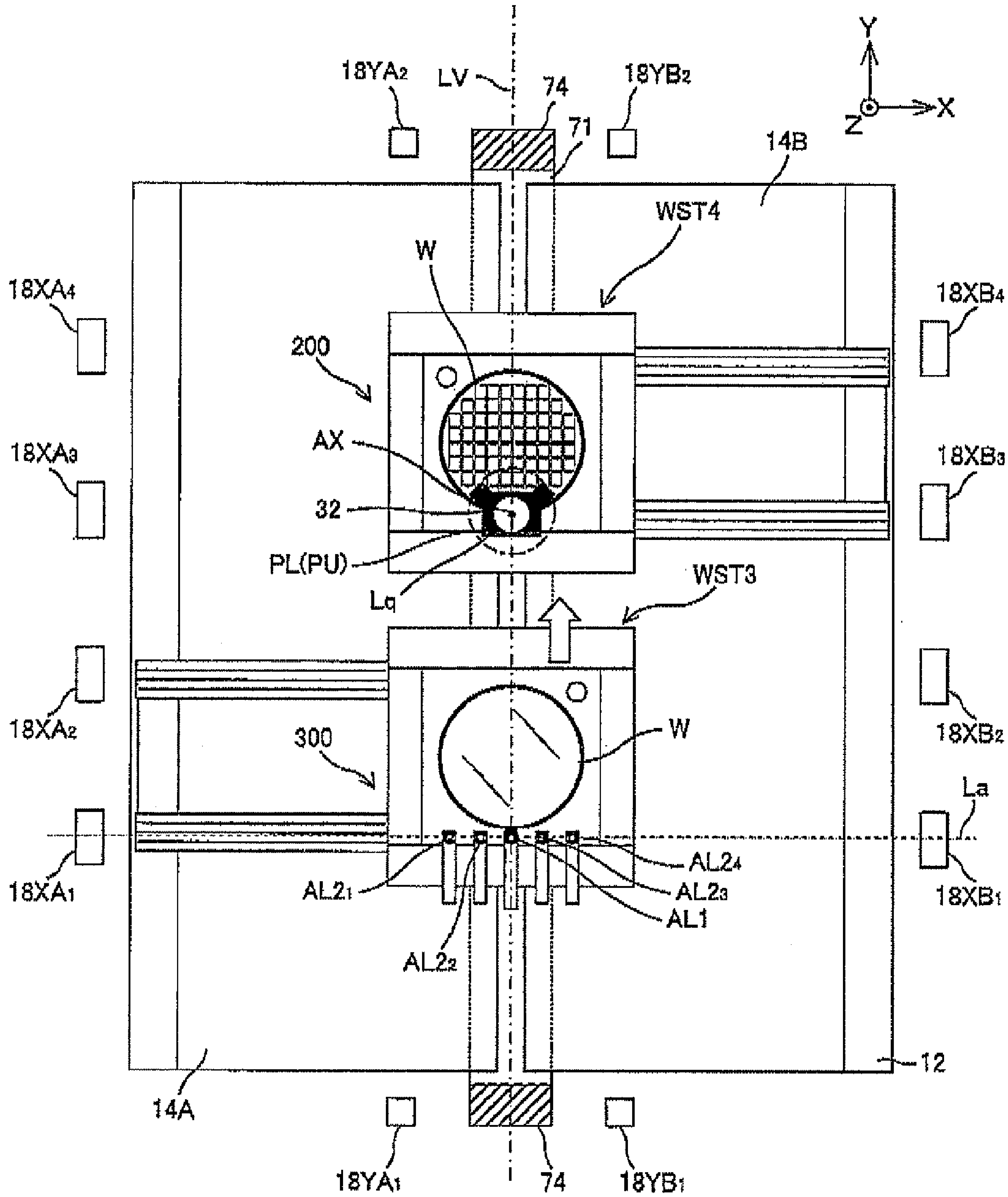
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Fig. 29

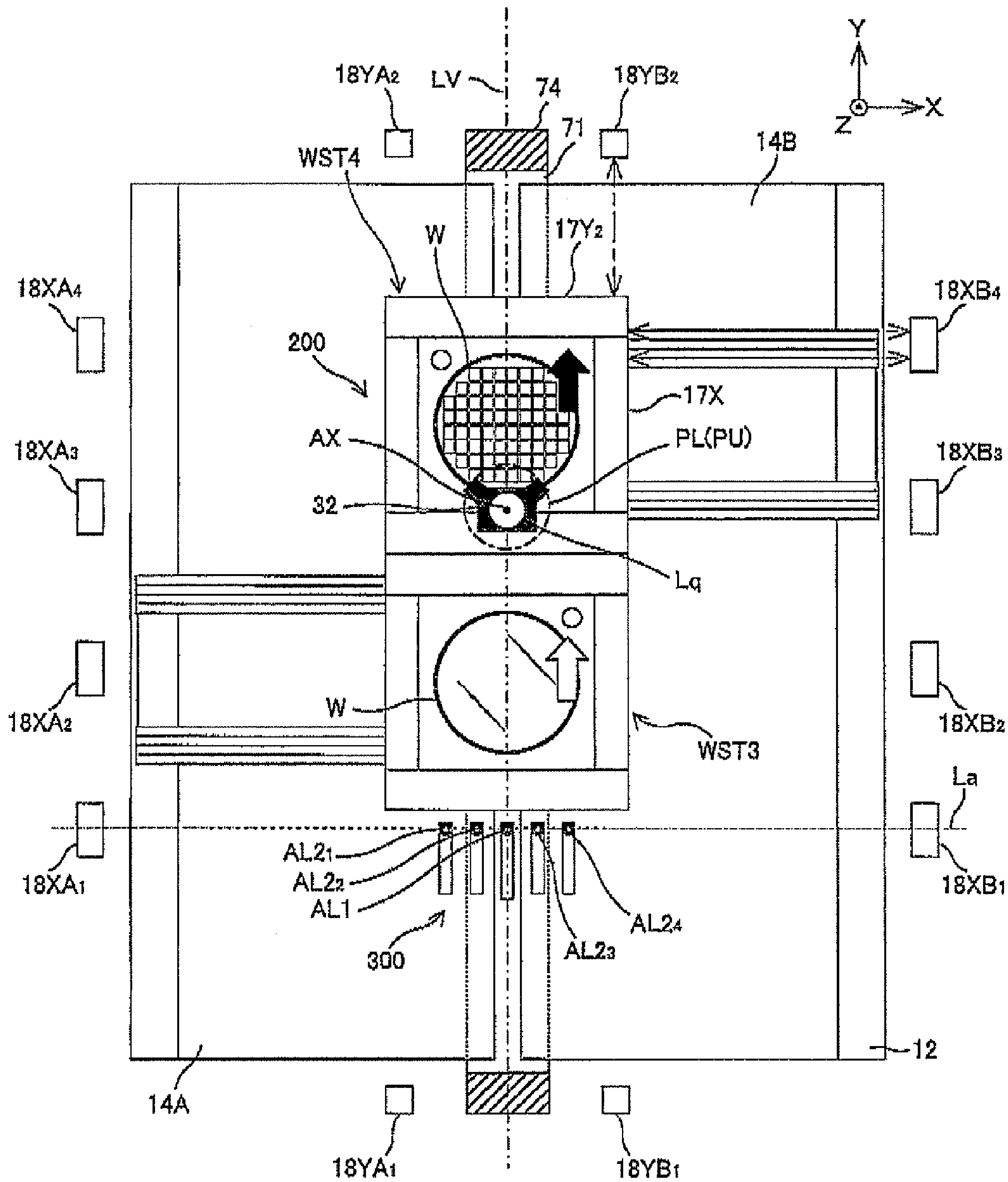

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Fig. 30

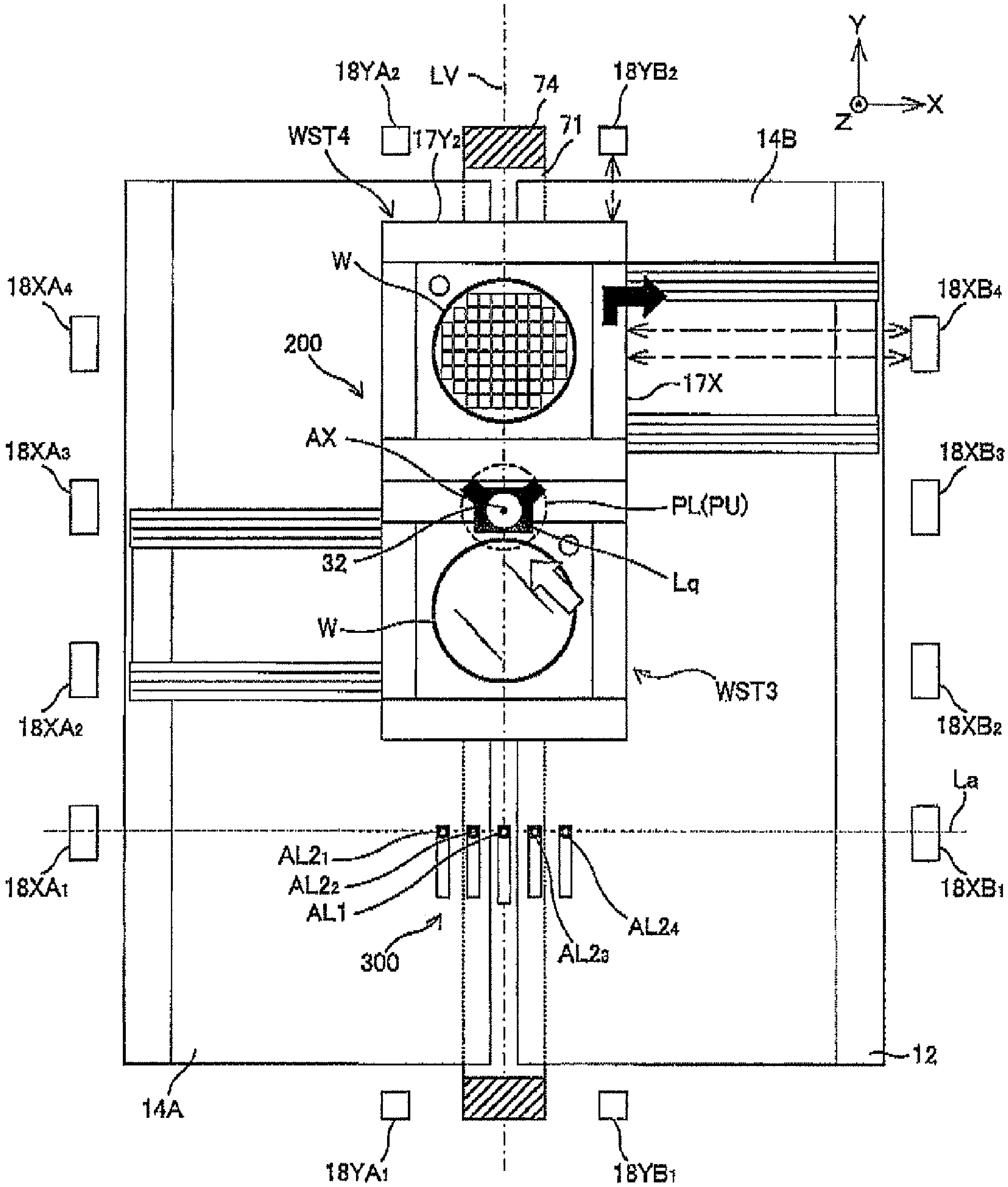
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Fig. 31

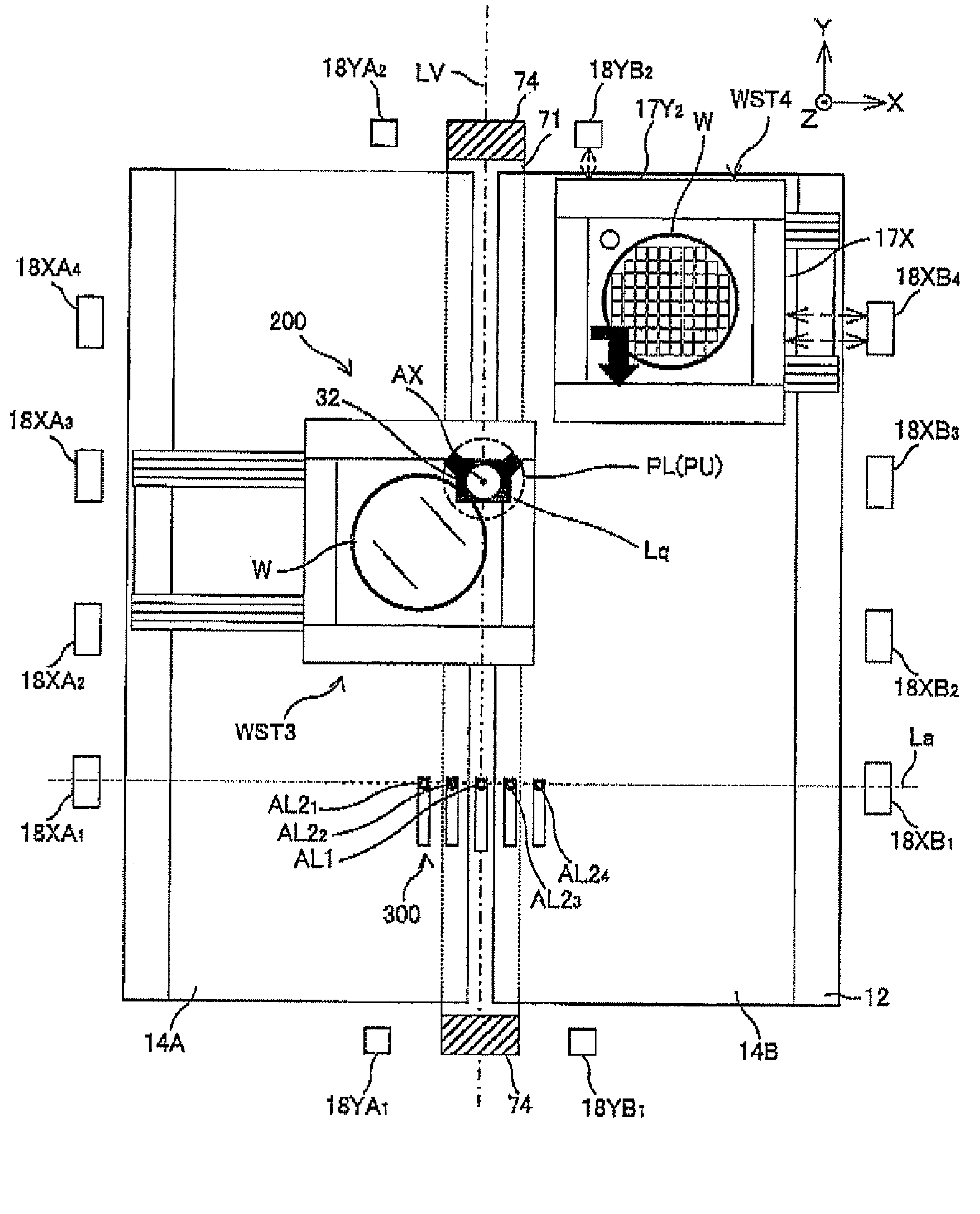

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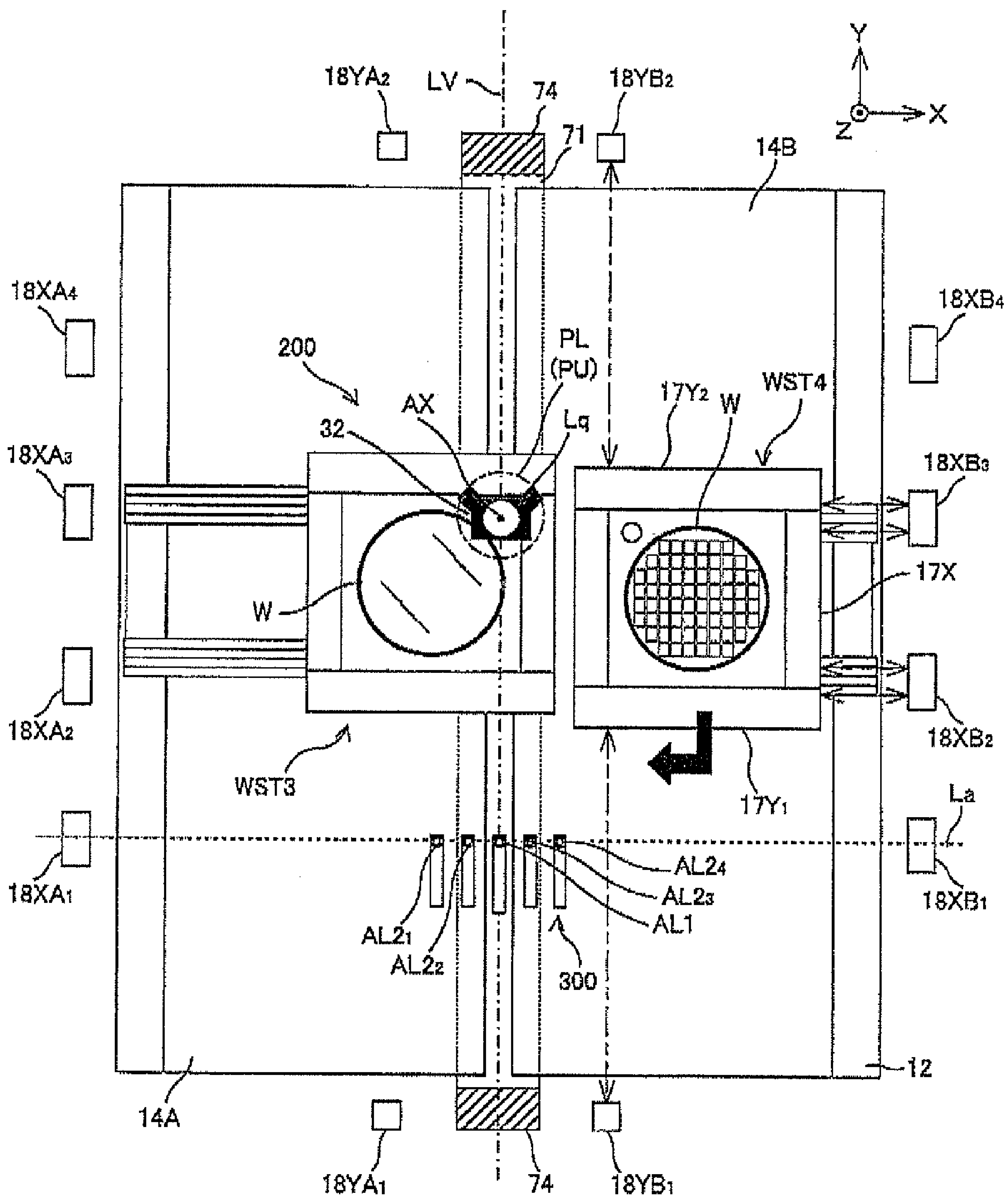
Fig. 32



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EXPOSURE APPARATUS AND DEVICE MANUFACTURING METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

This non-provisional application claims the benefit of Provisional Application No. 61/218,475 filed Jun. 19, 2009, the disclosure of which is hereby incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to exposure apparatuses and device manufacturing methods, and more particularly to an exposure apparatus that exposes an object with an energy beam via an optical system, and a device manufacturing method that uses the exposure apparatus.

2. Description of the Background Art

Conventionally, in a lithography process for manufacturing electron devices (microdevices) such as semiconductor devices (integrated circuits or the like) or liquid crystal display elements, an exposure apparatus such as a projection exposure apparatus by a step-and-repeat method (a so-called stepper), or a projection exposure apparatus by a step-and-scan method (a so-called scanning stepper (which is also called a scanner)) is mainly used.

In this type of the projection exposure apparatus, a stage device that accurately drives a stage that moves along a predetermined two-dimensional plane while holding a wafer is provided, in order to overlay and form device patterns on a substrate such as a wafer or a glass plate (hereinafter, generically referred to as a wafer). In this case, in order to improve the throughput, it is required for the stage device to drive the stage at high speed with high acceleration. Therefore, for example, as disclosed in U.S. Pat. No. 6,437,463, a stage device has been developed that has a configuration of driving a stage using a planar motor by an electromagnetic force drive method. Incidentally, the planar motor is configured of a stator arranged in a surface plate that holds the stage and a mover arranged in the stage.

Furthermore, it is required for the stage device to position a wafer with respect to the device patterns with high precision by driving the stage such that device patters are overlaid and formed with high precision. Therefore, in order to respond to such requirement, for example, in the fifth embodiment of U.S. Patent Application Publication No. 2008/0094594, a two-dimensional encoder system is enclosed that measures positional information of a stage by irradiating a grating arranged at the stage with a measurement beam from directly below and receiving reflected/diffracted light from the grating. In the two-dimensional encoder system related to the fifth embodiment of U.S. Patent Application Publication No. 2008/0094594, a two-dimensional encoder (a head section that emits the measurement beam) is fixed to a surface plate that supports the stage. Therefore, if the two-dimensional encoder system described in U.S. Patent Application Publication No. 2008/0094594 is applied to the previously-described stage device (U.S. Pat. No. 6,437,463) having a configuration that uses the planar motor without any changes, a reaction force accompanying a drive force used to drive the stage causes vibration of the surface plate at which the two-dimensional encoder (head section) is arranged, thereby the measurement accuracy of the two-dimensional encoder system is degraded, and as a consequence, there is a risk that the position control accuracy is degraded.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention, there is provided a first exposure apparatus that exposes an object with an energy beam via an optical system and a liquid, the apparatus comprising: a first and a second movable bodies which independently move on a guide surface parallel to a two-dimensional plane while each holding the object, and at each of which a measurement surface parallel to the two-dimensional plane is arranged; a guide surface forming member that forms the guide surface; a liquid supply device that supplies the liquid to a space between the optical system and the object held by the first or second movable body; a first measurement system that irradiates the measurement surface of the first or second movable body that moves within a first area, with a measurement beam from a side opposite to the optical system with respect to the guide surface forming member, and receives light from the measurement surface, thereby obtaining positional information of the first or second movable body; and a second measurement system that, when one of the first and second movable bodies located within the first area moves in proximity to the other of the first and second movable bodies and thereby the liquid supplied on the one of the movable bodies moves onto the other of the movable bodies, obtains at least positional information of the other of the movable bodies.

With this apparatus, when the liquid supplied on one of the first and second movable bodies located in the first area is moved onto the other of the first and second movable bodies, the first measurement system obtains the positional information of the one of the movable bodies with high precision and the second measurement system obtains at least the positional information of the other of the movable bodies with high precision. Consequently, by moving the first and second movable bodies in proximity to each other based on theses measurement results, the liquid supplied, on the one of the movable bodies can be moved onto the other of the movable bodies.

In this case, the guide surface is used to guide the movable body in a direction orthogonal to the two-dimensional plane and can be of a contact type or a noncontact type. For example, the guide method of the noncontact type includes a configuration using static gas bearings such as air pads, a configuration using magnetic levitation, and the like. Further, the guide surface is not limited to a configuration in which the movable body is guided following the shape of the guide surface. For example, in the configuration using static gas bearings such as air pads described above, the opposed surface of the guide surface forming member that is opposed to the movable body is finished so as to have a high flatness degree and the movable body is guided in a noncontact manner via a predetermined gap so as to follow the shape of the opposed surface. On the other hand, in the configuration in which while a part of a motor or the like that uses an electromagnetic force is placed at the guide surface forming member, a part of the motor or the like is also placed at the movable body, and a force acting in a direction orthogonal to the two-dimensional plane described above is generated by the guide surface forming member and the movable body cooperating, the position of the movable body is controlled, by the force, on a predetermined two-dimensional plane. For example, a configuration is also included in which a planar motor is arranged at the guide surface forming member and forces in directions which include two directions orthogonal to each other within the two-dimensional plane and a direction orthogonal to the two-dimensional plane are generated on the movable body and the movable body is levitated in a noncontact manner without arranging the static gas bearings described above.

According to a second aspect of the present invention, there is provided a second exposure apparatus that exposes an object with an energy beam via an optical system, the apparatus comprising: a first and a second movable bodies which independently move on a guide surface parallel to a two-dimensional plane while each holding the object, and at each of which a measurement surface parallel to the two-dimensional plane is arranged; a guide surface forming member that forms the guide surface; a first measurement system that irradiates the measurement surface of the first or second movable body that moves within a first area, with a measurement beam from a side opposite to the optical system with respect to the guide surface forming member, and receives light from the measurement surface, thereby obtaining positional information of the first or second movable body; a mark detecting system that detects a plurality of marks formed on the object held by the first or second movable body within a second area that is away from the first area; a second measurement system that obtains positional information of the first and second movable bodies that move within a third area that includes an area between the first and second areas; and a third measurement system that irradiates the measurement surface of the first or second movable body that moves within the second area, with a measurement beam from a side opposite to the optical system with respect to the guide surface forming member, and receives light from the measurement surface, thereby obtaining positional information of the first or second movable body.

With this apparatus, it is possible to make the first and second movable bodies move between the first and second areas passing through the third area, using the positional information obtained by the first to third measurement systems.

According to a third aspect of the present invention, there is provided a third exposure apparatus that exposes an object with an energy beam via an optical system and a liquid, the apparatus comprising: a first and a second movable bodies each of which includes a first movable body member that is movable on a guide surface parallel to a two-dimensional plane while holding the object, and a second movable body member that is placed on an outer side of the first movable body member supports the first movable body member relatively movable, is movable on the guide surface, and has a measurement surface parallel to the two-dimensional plane arranged, thereon; a liquid supply device that supplies the liquid to a space between the optical system and the object held by the first or second movable body; a first measurement system that irradiates the measurement surface of the first or second movable body that moves within a first area, with a measurement beam from a side opposite to the optical system, and receives light from the measurement surface, thereby obtaining positional information of the first or second movable body; and a second measurement system that, when the liquid supplied on one of the first and second movable bodies located within the first area is moved onto the other of the first and second movable bodies, obtains at least positional information of the other of the movable bodies.

With this apparatus, when the liquid supplied on one of the first and second movable bodies located within the first area is moved onto the other of the first and second movable bodies, the first measurement system obtains the positional information of the one of the movable bodies that moves within the first area and the second measurement system obtains at least the positional information of the other of the movable bodies with. Therefore, the liquid supplied on the one of the movable bodies can be moved onto the other of the movable bodies while the positional information of both the first and second movable bodies is obtained.

According to a fourth aspect of the present invention, there is provided a fourth exposure apparatus that exposes an object with an energy beam via an optical system and a liquid, the apparatus comprising: a first and a second movable bodies each of which includes a first movable body member that is movable on a guide surface parallel to a two-dimensional plane while holding the object, and a second movable body member that is placed on an outer side of the first movable body member, supports the first movable body member relatively movable, and is movable on the guide surface; a liquid supply device that supplies the liquid to a space between the optical system and the object held by the first or second movable body; and a control system that moves the liquid supplied on one of the movable bodies onto the other of the movable bodies by driving the first and second movable bodies to cause the first and second movable body members, which the first and second movable bodies each have, to be in proximity in one axial direction within the two-dimensional plane and also cause the second movable body member of the first movable body and the second movable body member of the second movable body to be in proximity, and moving the first and second movable bodies in the one axial direction while maintaining the proximity state.

With this apparatus, the control system causes the first and second movable body members, which each of the first and second movable bodies has, to be in proximity in the one axial direction within the two-dimensional plane and also causes the second movable body member of the first movable body and the second movable body member of the second movable body to be in proximity by driving the first and second movable bodies, and moves the first and second movable bodies in the one axial direction while maintaining the proximity state, thereby moving the liquid supplied on one of the movable bodies onto the other of the movable bodies. Therefore the liquid supplied on one of the first and second movable bodies can be moved onto the other.

According to a fifth aspect of the present invention, there is provided a device manufacturing method, comprising: exposing an object using any one of the first to fourth exposure apparatuses of the present invention; and developing the exposed object.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings;

FIG. **1** is a view schematically showing a configuration of an exposure apparatus of a first embodiment;

FIG. **2** is a plan view of the exposure apparatus of FIG. **1**;

FIG. **3** is a side view of the exposure apparatus of FIG. **1** when viewed from the +Y side;

FIG. **4**A is a plan view of a wafer stage which the exposure apparatus of FIG. **1** is equipped with, FIG. **4**B is an end view of the cross section taken along the line B-B of FIG. **4**A, and FIG. **4**C is an end view of the cross section taken along the line C-C of FIG. **4**A;

FIG. **5** is a view showing a configuration of a fine movement stage position measuring system;

FIG. **6** is a block diagram used to explain input/output relations of a main controller which the exposure apparatus of FIG. **1** is equipped with;

FIG. **7** is a view (No. 1) used to explain the procedure to expose a wafer using two wafer stages in the exposure apparatus of FIG. **1**;

FIG. **8** is a view (No. 2) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of FIG. **1**;

FIG. **9** is a view (No. 3) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of FIG. **1**;

FIG. **10** is a view (No. 4) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of FIG. **1**;

FIG. **11** is a view (No. 5) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of FIG. **1**;

FIG. **12** is a view (No. 6) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of FIG. **1**;

FIG. **13** is a view (No. 7) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of FIG. **1**;

FIG. **14** is a view used to explain an example of a modified configuration of a wafer stage and the movement procedure of a liquid immersion area Lq between two wafer stages;

FIG. **15** is a plan view of an exposure apparatus of a second embodiment;

FIG. **16**A is a plan view of a wafer stage which the exposure apparatus of the second embodiment is equipped with, and FIG. **16**B is an end view of a cross section taken along the B-B line in FIG. **16**A;

FIG. **17** is a view showing a configuration of a stage position measuring system;

FIG. **18** is a block diagram showing a configuration of a control system of the exposure apparatus of the second embodiment;

FIG. **19** is a view (No. 1) used to explain the procedure to expose a wafer using two wafer stages in the exposure apparatus of the second embodiment;

FIG. **20** is a view (No. 2) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of the second embodiment;

FIG. **21** is a view (No. 3) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of the second embodiment;

FIG. **22** is a view (No. 4) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of the second embodiment;

FIG. **23** is a view (No. 5) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of the second embodiment;

FIG. **24** is a view (No. 6) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of the second embodiment;

FIG. **25** is a view (No. 7) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of the second embodiment;

FIG. **26** is a view (No. 8) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of the second embodiment;

FIG. **27** is a view (No. 9) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of the second embodiment;

FIG. **28** is a view (No. 10) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of the second embodiment;

FIG. **29** is a view (No. 11) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of the second embodiment;

FIG. **30** is a view (No. 12) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of the second embodiment;

FIG. **31** is a view (No. 13) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of the second embodiment; and

FIG. **32** is a view (No. 14) used to explain the procedure to expose a wafer using the two wafer stages in the exposure apparatus of the second embodiment.

DESCRIPTION OF THE EMBODIMENTS

First Embodiment

A first embodiment of the present invention is described below, with reference to FIGS. **1** to **13**.

FIG. **1** schematically shows a configuration of an exposure apparatus **100** related to the first embodiment. Exposure apparatus **100** is a projection exposure apparatus by a step-and-scan method, which is a so-called scanner. As described later on, a projection optical system PL is provided in the embodiment, and in the description below, the explanation is given assuming that a direction parallel to an optical axis AX of projection optical system PL is a Z-axis direction, a direction in which a reticle and a wafer are relatively scanned within a plane orthogonal to the Z-axis direction is a Y-axis direction, and a direction orthogonal to the Z-axis and the Y-axis is an X-axis direction, and rotational (tilt) directions around the X-axis, Y-axis and Z-axis are θx, θy and θz directions, respectively.

As shown in FIG. **1**, exposure apparatus **100** is equipped with an exposure station (exposure processing area) **200** placed in the vicinity of the +Y side end on a base board **12**, a measurement station (measurement processing area) **300** placed in the vicinity of the −Y side end on base board **12**, a stage device **50** that includes two wafer stages WST**1** and WST**2**, their control system and the like. In FIG. **1**, wafer stage WST**1** is located in exposure station **200** and a wafer W is held on wafer stage WST**1**. And, wafer stage WST**2** is located in measurement station **300** and another wafer W is held on wafer stage WST**2**.

Exposure station **200** is equipped with an illuminations system **10**, a reticle stage RST, a projection unit PU, a local liquid immersion device **8**, and the like.

Illumination system **10** includes: a light source; and an illumination optical system that has an illuminance uniformity optical system including an optical integrator and the like, and a reticle blind and the like (none of which are illustrated), as disclosed in, for example, U.S. Patent Application Publication No. 2003/0025890 and the like. Illumination system **10** illuminates a slit-shaped illumination area IAR, which is defined by the reticle blind (which is also referred to as a masking system), on reticle R with illumination light (exposure light) IL with substantially uniform illuminance. As illumination light IL, ArF excimer laser light (wavelength: 193 nm) is used as an example.

On reticle stage RST, reticle R having a pattern surface (the lower surface in FIG. **1**) on which a circuit pattern and the like are formed is fixed by, for example, vacuum adsorption. Reticle stage RST can be driven with a predetermined stroke at a predetermined scanning speed in a scanning direction (which is the Y-axis direction being a lateral direction of the page surface of FIG. **1**) and can also be finely driven in the

X-axis direction, with a reticle stage driving system **11** (not illustrated in FIG. **1**, see FIG. **6**) including, for example, a linear motor or the like.

Positional information within the XY plane (including rotational information in the θz direction) of reticle stage RST is constantly detected at a resolution of, for example, around 0.25 nm with a reticle laser interferometer (hereinafter, referred to as a "reticle interferometer") **13** via a movable mirror **15** fixed to reticle stage RST (actually, a Y movable mirror (or a retroreflector) that has a reflection surface orthogonal to the Y-axis direction and an X movable mirror that has a reflection surface orthogonal to the X-axis direction are arranged). The measurement values of reticle interferometer **13** are sent to a main controller **20** (not illustrated in FIG. **1**, see FIG. **6**). Incidentally, as disclosed in, for example, PCT International Publication No. 2007/083758 (the corresponding U.S. Patent Application Publication No. 2007/0288121) and the like, the positional information of reticle stage RST can be measured by an encoder system.

Above reticle stage RST, a pair of reticle alignment systems RA_1 and RA_2 by an image processing method, each of which has an imaging device such as a CCD and uses light with an exposure wavelength (illumination light IL in the embodiment) as alignment illumination light, are placed (in FIG. **1**, reticle alignment system RA_2 hides behind reticle alignment system RA_1 in the depth of the page surface), as disclosed in detail in, for example, U.S. Pat. No. 5,646,413 and the like. Main controller **20** detects projected images of a pair of reticle alignment marks (the illustration is omitted) formed on reticle R and a pair of first fiducial marks on a measurement plate, which is described later, on fine movement stage WFS**1** (or WFS**2**), that correspond to the reticle alignment marks via projection optical system PL in a state where the measurement plate is located directly under projection optical system PL, and the pair of reticle alignment systems RA_1 and RA_2 are used to detect a positional relation between the center of a projection area of a pattern of reticle R by projection optical system. PL and a fiducial position on the measurement plate, i.e., the center of the pair of the first fiducial marks, according to such detection performed by main controller **20**. The detection signals of reticle alignment systems RA_1 and RA_2 are supplied to main controller **20** (see FIG. **6**) via a signal processing system that is not illustrated. Incidentally, reticle alignment systems RA_1 and RA_2 do not have to be arranged. In such a case, it is preferable that a detection system that has a light-transmitting section (photodetection section) arranged at a fine movement stage, which is described later on, is installed so as to detect projected images of the reticle alignment marks, as disclosed in, for example, U.S. Patent Application Publication No. 2002/0041377 and the like.

Projection unit PU is placed below reticle stage RST in FIG. **1**. Projection unit PU is supported, via a flange section FLG that is fixed to the outer periphery of projection unit PU, by a main frame (which is also referred to as a metrology frame) BD that is horizontally supported by a support member that is not illustrated. Main frame BD can be configured such that vibration from the outside is not transmitted to the main frame or the main frame does not transmit vibration to the outside, by arranging a vibration isolating device or the like at the support member. Projection unit PU includes a barrel **40** and projection optical system PL held within barrel **40**. As projection optical system. PL, for example, a dioptric system that is composed of a plurality of optical elements (lens elements) that are disposed along optical axis AX parallel to the Z-axis direction is used. Projection optical system PL is, for example, both-side telecentric and has a predetermined projection magnification (e.g. one-quarter, one-fifth, one-eighth times, or the like). Therefore, when illumination area TAR on reticle R is illuminated with illumination light XL from illumination system **10**, illumination light IL passes through reticle R whose pattern surface is placed substantially coincident with a first plane (object plane) of projection optical system PL. Then, a reduced image of a circuit pattern (a reduced image of a part of a circuit pattern) of reticle R within illumination area IAR is formed in an area (hereinafter, also referred to as an exposure area) IA that is conjugate to illumination area IAR described above on wafer W, which is placed on the second plane (image plane) side of projection optical system PL and whose surface is coated with a resist (sensitive agent), via projection optical system PL (projection, unit PU). Then, by moving reticle R relative to illumination area IAR (illumination light IL) in the scanning direction (Y-axis direction) and also moving wafer W relative to exposure area IA (illumination light IL) in the scanning direction (Y-axis direction) by synchronous drive of reticle stage RST and wafer stage WST**1** (or WST**2**), scanning exposure of one shot area (divided area) on wafer W is performed. Accordingly, a pattern of reticle R is transferred onto the shot area. More specifically, in the embodiment, a pattern of reticle R is generated on wafer W by illumination system **10** and projection optical system PL, and the pattern is formed on wafer W by exposure of a sensitive layer (resist layer) on wafer W with illumination light IL. In this case, projection unit PU is held by main frame BD, and in the embodiment, main frame BD is substantially horizontally supported by a plurality (e.g. three or four) of support members placed on an installation surface (such as a floor surface) each via a vibration isolating mechanism. Incidentally, the vibration isolating mechanism can be placed between each of the support members and main frame BD. Further, as disclosed in, for example, PCT International Publication No. 2006/039952, main frame BD (projection unit PU) can be supported in a suspended manner by a main frame member (not illustrated) placed above projection unit PU or a reticle base or the like.

Local liquid immersion device **8** includes a liquid supply device **5**, a liquid recovery device **6** (none of which are illustrated in FIG. **1**, see FIG. **6**), and a nozzle unit **32** and the like. As shown in FIG. **1**, nozzle unit **32** is supported in a suspended manner by main frame BD that supports projection unit PU and the like, via a support member that is not illustrated, so as to enclose the periphery of the lower end of barrel **40** that holds an optical element closest to the image plane side (wafer W side) that configures projection optical system PL, which is a lens (hereinafter, also referred to as a "tip lens") **191** in this case. Nozzle unit **32** is equipped with a supply opening and a recovery opening of a liquid Lq, a lower surface to which wafer W is placed so as to be opposed and at which the recovery opening is arranged, and a supply flow channel and a recovery flow channel that are respectively connected to a liquid supply pipe **31**A and a liquid recovery pipe **31**B (none of which are illustrated in FIG. **1**, see FIG. **2**). One end of a supply pipe (not illustrated) is connected to liquid supply pipe **31**A, while the other end of the supply pipe is connected to liquid supply device **5**, and one end of a recovery pipe (not illustrated) is connected to liquid recovery pipe **31**B, while the other end of the recovery pipe is connected to liquid recovery device **6**.

In the embodiment, main controller **20** controls liquid supply device **5** (see FIG. **6**) to supply the liquid to the space between tip lens **191** and wafer W and also controls liquid recovery device **6** (see FIG. **6**) to recover the liquid from the space between tip lens **191** and wafer W. On this operation, main controller **20** controls the quantity of the supplied liquid and the quantity of the recovered liquid in order to hold a constant quantity of liquid Lq (see FIG. **1**) while constantly replacing the liquid in the space between tip lens **191** and wafer W. In the embodiment as the liquid described above, a pure water (with a refractive index n≈1.44) that transmits the ArF excimer laser light (the light with a wavelength of 193 nm) is to be used.

Measurement station **300** is equipped with an alignment device **99** arranged at main frame BD. Alignment device **99** includes five alignment systems AL**1** and $AL2_1$ to $AL2_4$ shown in FIG. **2**, as disclosed in, for example, U.S. Patent Application Publication No. 2008/0088643 and the like. To be more specific, as shown in FIG. **2**, a primary alignment system AL**1** is placed in a state where its detection center is located at a position a predetermined distance apart on the −Y side from optical axis AX, on a straight line (hereinafter, referred to as a reference axis) LV that passes through the center of projection unit PU (which is optical axis AX of projection optical system PL, and in the embodiment, which also coincides with the center of exposure area IA described previously) and is parallel to the Y-axis. On one side and the other side in the X-axis direction with primary alignment system AL**1** in between, secondary alignment systems $AL2_1$ and $AL2_2$, and $AL2_3$ and $AL2_4$, whose detection centers are substantially symmetrically placed with respect to reference axis LV, are arranged respectively. Mote specifically, the detection centers of the five alignment systems AL**1** and $AL2_1$ to $AL2_4$ are placed along a straight line (hereinafter, referred to as a reference axis) La that vertically intersects reference axis LV at the detection center of primary alignment system AL**1** and is parallel to the X-axis. Note that a configuration including the five alignment systems AL**1** and $AL2_1$ to $AL2_4$ and a holding device (slider) that holds these alignment systems is shown as alignment device **99** in FIG. **1**. As disclosed in, for example, U.S. Patent Application Publication No. 2009/0233234 and the like, secondary alignment systems $AL2_1$ to $AL2_4$ are fixed to the lower surface of main frame BD via the movable slider (see FIG. **1**), and the relative positions of the detection areas of the secondary alignment systems are adjustable at least in the X-axis direction with a drive mechanism that is not illustrated.

In the embodiment, as each of alignment systems AL**1** and $AL2_1$ to $AL2_4$, for example, an FIA (Field Image Alignment) system by an image processing method is used. The configurations of alignment systems AL**1** and $AL2_1$ to $AL2_4$ are disclosed in detail in, for example, PCT International Publication No. 2008/056735 and the like. The imaging signal from each of alignment systems AL**1** and $AL2_1$ to $AL2_4$ is supplied to main controller **20** (see FIG. **6**) via a signal processing system that is not illustrated.

Note that exposure apparatus **100** has a first loading position where a carriage operation of a wafer is performed with respect to wafer stage WST**1** and a second loading position where a carriage operation of a wafer is performed with respect to wafer stage WST**2**, although the loading positions are not illustrated. In the case of the embodiment, the first loading position is arranged on the surface plate **14**A side and the second loading position is arranged on the surface plate **14**B side.

As shown in FIG. **1**, stage device **50** is equipped with base board **12**, a pair of surface plates **14**A and **14**B placed above base board **12** (in FIG. **1**, surface plate **14**B hides behind surface plate **14** in the depth of the page surface), the two wafer stages WST**1** and WST**2** that move on a guide surface parallel to the XY plane that is formed by the upper surfaces of the pair of surface plates **14**A and **14**B, tube carriers TCa and TCb (tube carrier TCb is not illustrated in FIG. **1**, see the drawings such as FIGS. **2** and **3**) that are respectively connected to wafer stages WST**1** and WST**2** via piping/wiring systems (hereinafter, referred to as tubes for the sake of convenience) Ta_2 and Tb_2 (not illustrated in FIG. **1**, see FIGS. **2** and **3**) a measurement system that measures positional information of wafer stages WST**1** and WST**2**, and the like. The electric power for various types of sensors and actuators such as motors, the coolant for temperature adjustment to the actuators, the pressurized air for air bearings, and the like are supplied from the outside to wafer stages WST**1** and WST**2** via tubes Ta_2 and Tb_2, respectively. Note that, in the description below, the electric power, the coolant for temperature adjustment, the pressurized air and the like are also referred to as the power usage collectively. In the case where a vacuum suction force is necessary, the force for vacuum (negative pressure) is also included in the power usage.

Base board **12** is made up of a member having a tabular outer shape, and as shown in FIG. **1**, is substantially horizontally (parallel to the XY plane) supported via a vibration isolating mechanism (the illustration is omitted) on a floor surface **102**. In the center portion in the X-axis direction of the upper surface of base board **12**, a recessed section **12***a* (recessed groove) extending in a direction parallel to the Y-axis is formed, as shown in FIG. **3**. On the upper surface side of base board **12** (excluding a portion where recessed section **12***a* is formed, in this case), a coil unit (the illustration is omitted) is housed that includes a plurality of coils placed in a matrix shape with the XY two-dimensional directions serving as a row direction and a column direction.

As shown in FIG. **2**, surface plates **14**A and **14**B are each made up of a rectangular plate-shaped member whose longitudinal direction is in the Y-axis direction in a planar view (when viewed from above) and are respectively placed on the −X side and the +X side of reference axis LV. Surface plate **14**A and surface plate **14**B are placed with a very narrow gap in between in the X-axis direction, symmetric with respect to reference axis LV. By finishing the upper surface (the +Z side surface) of each of surface plates **14**A and **14**B such that the upper surface has a very high flatness degree, it is possible to make the upper surfaces function as a guide surface with respect to the Z-axis direction used when each of wafer stages WST**1** and WST**2** moves following the XY plane. Alternatively, a configuration can be employed in which a force in the Z direction is made to act on wafer stages WST**1** and WST**2** by planar motors, which are described later on, to magnetically levitate wafer stages WST**1** and WST**2** above surface plates **14**A and **14**B. In the case of the embodiment, the configuration that uses the planar motors is employed and static gas bearings are not used, and therefore, the flatness degree of the upper surfaces of surface plates **14**A and **14**B does not have to be so high as in the above description.

As shown in FIG. **3**, surface plates **14**A and **14**B are supported on upper surfaces **12***b* of both side portions of recessed section **12***a* of base board **12** via air bearings (or rolling bearings) that are not illustrated.

Surface plates **14**A and **149** respectively have first sections $14A_1$ and $14B_1$ each having a relatively thin plate shape on the upper surface of which the guide surface is formed, and second sections $14A_2$ and $14B_2$ each having a relatively thick plate shape and being short in the X-axis direction that are integrally fixed to the lower surfaces of first sections $14A_1$ and $14B_1$, respectively. The end on the +X side of first section $14A_1$ of surface plate **14**A slightly overhangs, to the +X side, the end surface on the +X side of second section $14A_2$, and the end on the −X side of first section $14B_1$ of surface plate **14**B slightly overhangs, to the −X side, the end surface on the −X side of second section $14B_2$. However, the configuration is not limited to the above-described one, and a configuration can be employed in which the overhangs are not arranged.

Inside each of first sections **14**A_1 and **14**B_1, a coil unit (the illustration is omitted) is housed that includes a plurality of coils placed in a matrix shape with the XY two-dimensional directions serving as a row direction and a column direction. The magnitude and direction of the electric current supplied to each of the plurality of coils that configure each of the coil units are controlled by main controller **20** (see FIG. **6**).

Inside (on the bottom portion of) second section **14**A_2 of surface plate **14**A, a magnetic unit (the illustration is omitted), which is made up of a plurality of permanent magnets (and yokes that are not illustrated) placed in a matrix shape with the XY two-dimensional directions serving as a row direction and a column direction, is housed so as to correspond to the coil unit housed on the upper surface side of base board **12**. The magnetic unit configures, together with the coil unit of base board **12**, a surface plate driving system **60**A (see FIG. **6**) that is made up of a planar motor by the electromagnetic force (Lorentz force) drive method that is disclosed in, for example, U.S. Patent Application Publication No. 2003/0085676 and the like. Surface plate driving system **60**A generates a drive force that drives surface plate **14**A in directions of three degrees of freedom (X, Y, θz) within the XY plane.

Similarly, inside (on the bottom portion of) second section **14**B_2 of surface plate **14**B, a magnetic unit (the illustration is omitted) made up of a plurality of permanent magnets (and yokes that are not illustrated) is housed that configures, together with the coil unit of base board **12**, a surface plate driving system **60**B (see FIG. **5**) made up of a planar motor that drives surface plate **14**B in the directions of three degrees of freedom within the XY plane. Incidentally, the placement of the coil unit and the magnetic unit of the planar motor that configures each of surface plate driving systems **60**A and **60**B can be reverse (a moving coil type that has the magnetic unit on the base board side and the coil unit on the surface plate side) to the above-described case (a moving magnet type).

Positional information of surface plates **14**A and **14**B in the directions of three degrees of freedom is obtained (measured) independently from each other by a first surface plate position measuring system **69**A and a second surface plate position measuring system **69**B (see FIG. **6**), respectively, which each include, for example, an encoder system. The output of each of first surface plate position measuring system **69**A and second surface plate position measuring system **69**B is supplied to main controller **20** (see FIG. **6**), and main controller **20** controls the magnitude and direction of the electric current supplied to the respective coils that configure the coil units of surface plate driving systems **60**A and **60**B, using (based on) the outputs of surface plate position measuring systems **69**A and **69**B, thereby controlling the respective positions of surface plates **14**A and **14**B in the directions of three degrees of freedom within the XY plane, as needed. Main controller **20** drives surface plates **14**A and **14**B via surface plate driving systems **60**A and **60**B using (based on) the outputs of surface plate position measuring systems **69**A and **69**B to return surface plates **14**A and **14**B to the reference position of the surface plates such that the movement distance of surface plates **14**A and **14**B from the reference position falls within a predetermined range, when surface plates **14**A and **14**B function as countermasses to be described later on. More specifically, surface plate driving systems **60**A and **60**B are used as trim motors.

While the configurations of first surface plate position measuring system **69**A and second surface plate position measuring system **69**B are not especially limited, an encoder system can be used in which, for example, encoder heads, which obtain (measure) positional information of the respective surface plates **14**A and **14**B in the directions of three degrees of freedom within the XY plane by irradiating measurement beams on scales (e.g. two-dimensional gratings) placed on the lower surfaces of second sections **14**A_2 and **14**B_2 respectively and using reflected light (diffraction light from the two-dimensional gratings) obtained by the irradiation, are placed at base board **12** (or the encoder heads are placed at second sections **14**A_2 and **14**B_2 and scales are placed at base board **12**, respectively). Incidentally, it is also possible to obtain (measure) the positional information of surface plates **14**A and **14**B by, for example, an optical interferometer system or a measurement system that is a combination of an optical interferometer system and an encoder system.

One of the wafer stages, wafer stage WST**1** is equipped with a fine movement stage (which is also referred to as a table) WFS**1** that holds wafer W and a coarse movement stage WCS**1** having a rectangular frame shape that encloses the periphery of fine movement stage WFS**1**, as shown in FIG. **2**. The other of the wafer stages, wafer stage WST**2** is equipped with a fine movement stage WFS**2** that holds wafer W and a coarse movement stage WCS**2** having a rectangular frame shape that encloses the periphery of fine movement stage WFS**2**, as shown in FIG. **2**. As is obvious from FIG. **2**, wafer stage WST**2** has completely the same configuration including the drive system, the position measuring system and the like, as wafer stage WST**1** except that wafer stage WST**2** is placed in a state laterally reversed with respect to wafer stage WST**1**. Consequently, in the description below, wafer stage WST**1** is representatively focused on and described, and wafer stage WST**2** is described only in the case where such description is especially needed.

As shown in FIG. **4**A, coarse movement stage WCS**1** has a pair of coarse movement slider sections **90***a* and **90***b* which are placed parallel to each other, spaced apart in the Y-axis direction, and each of which is made up of a rectangular parallelepiped member whose longitudinal direction is in the X-axis direction, and a pair of coupling members **92***a* and **92***b* each of which is made up of a rectangular parallelepiped member whose longitudinal direction is in the Y-axis direction, and which couple the pair of coarse movement slider sections **90***a* and **90***h* with one ends and the other ends thereof in the Y-axis direction. More specifically, coarse movement stage WCS**1** is formed into a rectangular frame shape with a rectangular opening section, in its center portion, that penetrates in the Z-axis direction.

Inside (on the bottom portions of) coarse movement slider sections **90***a* and **90***b*, as shown in FIGS. **4**B and **4**C, magnetic units **96***a* and **96***b* are housed respectively. Magnetic units **96***a* and **96***b* correspond to the coil units housed inside first sections **14**A_1 and **14**B_1 of surface plates **14**A and **14**B, respectively, and are each made of up a plurality of magnets placed in a matrix shape with the XY two-dimensional directions serving as a row direction and a column direction. Magnetic units **96***a* and **96***b* configure, together with the coil units of surface plates **14**A and **14**B, a coarse movement stage driving system **62**A (see FIG. **6**) that is made up of a planar motor by the electromagnetic force (Lorentz force) drive method that is capable of generating drive forces in the directions of six degrees of freedom to coarse movement stage WCS**1**, which is disclosed in, for example, U.S. Patent Application Publication No. 2003/0085676 and the like. Further, similar thereto, magnetic units, which coarse movement stage WCS**2** (see FIG. **2**) of wafer stage WST**2** has, and the coil units of surface plates **14**A and **14**B configure a coarse movement, stage driving system **62**B (see FIG. **6**) made up of a planar motor. In this case, since a force in the Z-axis direction acts on coarse movement stage WCS**1** or WCS**2**), the coarse movement stage is magnetically levitated above surface plates **14**A and **14**B. Therefore, it is not necessary to use static gas bearings for which relatively high machining accuracy is required, and thus it becomes unnecessary to increase the flatness degree of the upper surfaces of surface plates **14**A and **14**B.

Incidentally, while coarse movement stages WCS**1** and WCS**2** of the embodiment have the configuration in which only coarse movement slider sections **90***a* and **90***b* have the magnetic units of the planar motors, this is not intended to be limiting, and the magnetic unit can be placed, also at coupling members **92***a* and **92***b*. Further, the actuators to drive coarse movement stages WCS**1** and WCS**2** are not limited to the planar motors by the electromagnetic force (Lorentz force) drive method, but for example, planar motors by a variable magnetoresistance drive method or the like can be used. Further, the drive directions of coarse movement stages WCS**1** and WCS**2** are not limited to the directions of six degrees of freedom, but can be, for example, only directions of three degrees of freedom (X, Y, θz) within the XY plane. In this case, coarse movement stages WCS**1** and WCS**2** should be levitated above surface plates **14**A and **14**B, for example, using static gas bearings (e.g. air bearings). Further, in the embodiment, while the planar motor of a moving magnet type is used as each of coarse movement stage driving systems **62**A and **62**B, this is not intended to be limiting, and a planar motor of a moving coil type in which the magnetic unit is placed at the surface plate and the coil unit is placed at the coarse movement stage can also be used.

On the side surface on the −Y side of coarse movement slider section **90***a* and on the side surface on the +Y side of coarse movement slider section **90***b*, guide members **94***a* and **94***b* that function as a guide used when fine movement stage WFS**1** is finely driven are respectively fixed. As shown in FIG. **4**B, guide member **94***a* is made up of a member having an L-like sectional shape arranged extending in the X-axis direction and its lower surface is placed flush with the lower surface of coarse movement slider section **90***a*. Guide member **94***b* is configured and placed similar to guide member **94***a*, although guide member **94***b* is bilaterally symmetric to guide member **94***a*.

Inside (on the bottom surface of) guide member **94***a*, a pair of coil units CUa, and CUb, each of which includes a plurality of coils placed in a matrix shape with the XY two-dimensional directions serving as a row direction and a column direction, are housed at a predetermined distance in the X-axis direction (see FIG. **4**A). Meanwhile, inside (on the bottom portion of) guide member **94***b*, one coil unit CUc, which includes a plurality of coils placed in a matrix shape with the XY two-dimensional directions serving as a row direction and a column direction, is housed (see FIG. **4**A). The magnitude and direction of the electric current supplied to each of the coils that configure coil units CUa to CUc are controlled by main controller **20** (see FIG. **6**).

Coupling members **92***a* and **92***b* are formed to be hallow, and piping members, wiring members and the like, which are not illustrated, used to supply the power usage to fine movement stage WFS**1** are housed inside. Inside coupling members **92***a* and/or **92***b*, various types of optical members (e.g. an aerial image measuring instrument, an uneven illuminance measuring instrument, an illuminance monitor, a wavefront aberration measuring instrument, and the like) can be housed.

In this case, when wafer stage WST**1** is driven with acceleration/deceleration in the Y-axis direction on surface plate **14**A, by the planar motor that configures coarse movement stage driving system **62**A (e.g. when wafer stage WST**1** moves between exposure station **200** and measurement station **300**), surface plate **14**A is driven in a direction opposite to wafer stage WST**1** according to the so-called law of action and reaction (the law of conservation of momentum) owing to the action of a reaction force by the drive of wafer stage WST**1**. Further, it is also possible to make a state where the law of action and reaction described above does not hold, by generating a drive force in the Y-axis direction with surface plate driving system **60**A.

Further, when wafer stage WST **2** is driven in the Y-axis direction on surface plate **14**B, surface plate **14**B is also driven in a direction opposite to wafer stage WST**2** according to the so-called law of action and reaction (the law of conservation of momentum) owing to the action of a reaction force of a drive force of wafer stage WST**2**. More specifically, surface plates **14**A and **14**B function as the countermasses and the momentum of a system composed of wafer stages WST**1** and WST**2** and surface plates **14**A and **14**B as a whole is conserved and movement of the center of gravity does not occur. Consequently, any inconveniences do not arise such as the uneven loading acting on surface plates **14**A and **14**B owing to the movement of wafer stages WST**1** and WST**2** in the Y-axis direction. Incidentally, regarding wafer stage WST**2** as well, it is possible to make a state where the law of action and reaction described above does not hold, by generating a drive force in the Y-axis direction with surface plate driving system **60**B.

Further, by the action of a reaction force of a drive force in the X-axis direction of wafer stages WST**1** and WST**2**, surface plates **14**A and **14**B function as the countermasses.

Further, the mirror polishing is applied to each of the side surface on the +Y side of coarse movement slider section **90***a*, the side surface on the −Y side of coarse movement slider **90***b* and the side surface on the −X side of coupling member **92***a*, and reflection surfaces **17**Y_2, **17**Y_1 and **17**X are formed. These reflection surfaces are used in position measurement of wafer stages WST**1** and WST**2** by coarse movement stage position measuring systems **68**A and **68**B to be described later on. Incidentally, instead of reflection surfaces **17**Y_2, **17**Y_1 and **17**X, a movable mirror composed of a planar mirror can be fixed to coarse movement slider sections **90***a* and **90***b* and coupling member **92***a*.

As shown in FIGS. **4**A and **4**B, fine movement stage WFS**1** is equipped with a main section **80** made up of a member having a rectangular shape in a planar view, a pair of fine movement slider sections **84***a* and **84***b* fixed to the side surface on the +Y side of main section **80**, and a fine movement slider section **84***c* fixed to the side surface on the −Y side of main section **80**.

Main section **80** is formed by a material with a relatively small coefficient of thermal expansion, e.g., ceramics, glass or the like, and is supported by coarse movement stage WCS**1** in a noncontact manner in a state where the bottom surface of the main section is located flush with the bottom surface of coarse movement stage WCS**1**. Main section **80** can be hollowed for reduction in weight. Incidentally, the bottom surface of main section **80** does not necessarily have to be flush with the bottom surface of coarse movement stage WCS**1**.

In the center of the upper surface of main section **80**, a wafer holder (not illustrated) that holds wafer W by vacuum adsorption or the like is placed. In the embodiment, the wafer holder by a so-called pin chuck method is used in which a plurality of support sections (pin members) that support wafer W are formed, for example, within an annular protruding section (rim section), and the wafer holder, whose one surface (front surface) serves as a wafer mounting surface, has a two-dimensional grating RG to be described later and the like arranged on the other surface (back surface) side. Incidentally, the wafer holder can be formed integrally with fine movement stage WFS**1** (main section **80**), or can be fixed to main section **80** so as to be detachable via, for example, a holding mechanism such as an electrostatic chuck mechanism or a clamp mechanism. In this case, grating RG is to be arranged on the back surface side of main section **80**. Further, the wafer holder can be fixed to main section **80** by an adhesive agent or the like. On the upper surface of main section **80**, as shown in FIG. **4**A, a plate (liquid-repellent plate) **82**, in the center of which a circular opening that is slightly larger than wafer W (wafer holder) is farmed and which has a rectangular outer shape (contour) that corresponds to main section **80**, is attached on the outer side of the wafer holder (mounting area of wafer W). The liquid-repellent treatment against liquid Lq is applied to the surface of plate **82** (the liquid-repellent surface is formed). In the embodiment, the surface of plate **82** includes a base material made up of metal, ceramics, glass or the like, and a film of liquid-repellent material formed on the surface of the base material. The liquid-repellent material includes, for example, PFA (Tetra fluoro ethylene-perfluoro alkylvinyl ether copolymer), PTFE (Poly tetra fluoro ethylene), Teflon (registered trademark) or the like. Incidentally, the material that forms the film can be an acrylic-type resin or a silicon-series resin. Further, the entire plate **82** can be formed with at least one of the PFA, PTFE, Teflon (registered trademark), acrylic-type resin and silicon-series resin. In the embodiment, the contact angle of the upper surface of plate **82** with respect to liquid Lq is, for example, more than or equal to 90 degrees. On the surface of coupling member **92***b* described previously as well, the similar liquid-repellent treatment is applied.

Plate **82** is fixed to the upper surface of main section **80** such that the entire surface (or a part of the surface) of plate **82** is flush with the surface of wafer W. Further, the surfaces of plate **82** and wafer W are located substantially flush with the surface of coupling member **92***b* described previously. Further, in the vicinity of a corner on the +X side located on the +Y side of plate **82**, a circular opening is formed, and a measurement plate FM**1** is placed in the opening without any gap therebetween in a state substantially flush with the surface of wafer W. On the upper surface of measurement plate FM**1**, the pair of first fiducial marks to be respectively detected by the pair of reticle alignment systems RA_1 and RA_2 (see FIGS. **1** and **6**) described earlier and a second fiducial mark to be detected by primary alignment system AL**1** (none of the marks are illustrated) are formed. In fine movement stage WFS**2** of wafer stage WST**2**, as shown in FIG. **2**, in the vicinity of a corner on the −X side located on the +Y side of plate **82**, a measurement plate FM**2** that is similar to measurement plate FM**1** is fixed in a state substantially flush with the surface of wafer W. Incidentally, instead of attaching plate **82** to fine movement stage WFS**1** (main section **80**), it is also possible, for example, that the wafer holder is formed integrally with fine movement stage WFS**1** and the liquid-repellent treatment is applied to the peripheral area, which encloses the wafer holder (the same area as plate **82** (which may include the surface of the measurement plate)), of the upper surface of fine movement stage WFS**1** and the liquid repellent surface is formed.

In the center portion of the lower surface of main section **80** of fine movement stage WFS**1**, as shown in FIG. **4**B, a plate having a predetermined thin plate shape, which is large to the extent of covering the wafer holder (mounting area of wafer W) and measurement plate FM**1** (or measurement plate FM**2** in fine movement stage WFS**2**), is placed in a state where its lower surface is located substantially flush with the other section (the peripheral section) (the lower surface of the plate does not protrude below the peripheral section). On one surface (the upper surface (or the lower surface)) of the plate, two-dimensional grating RG (hereinafter, simply referred to as grating RG) is formed. Grating RG includes a reflective diffraction grating (X diffraction grating) whose periodic direction is in the X-axis direction and, a reflective diffraction grating (Y diffraction grating) whose periodic direction is in the Y-axis direction. The plate is formed by, for example, glass, and grating RG is created by graving the graduations of the diffraction gratings at a pitch, for example, between 138 nm to 4 μm, e.g. at a pitch of 1 μm. Incidentally, grating RG can also cover the entire lower surface of main section **80**. Further, the type of the diffraction grating used for grating RG is not limited to the one on which grooves or the like are mechanically formed, but for example, a diffraction grating that is created by exposing interference fringes on a photosensitive resin can also be employed. Incidentally, the configuration of the plate having a thin plate shape is not necessarily limited to the above-described one.

As shown in **4**A, the pair of fine movement slider sections **84***a* and **84***b* are each a plate-shaped member having a roughly square shape in a planar view, and are placed apart at a predetermined distance in the X-axis direction, on the side surface on the +Y side of main section **80**. Fine movement slider section **84***c* is a plate-shaped member having a rectangular shape elongated in the X-axis direction in a planar view, and is fixed to the side surface on the −Y side of main section **80** in a state where one end and the other end in its longitudinal direction are located on straight lines parallel to the Y-axis that are substantially collinear with the centers of fine movement slider sections **84***a* and **84***b*.

The pair of fine movement slider sections **84***a* and **84***b* are respectively supported by guide member **94***a* described earlier, and fine movement slider section **84***c* is supported by guide member **94***b*. More specifically, fine movement stage WFS is supported at three noncollinear positions with respect to coarse movement stage WCS.

Inside fine movement slider sections **84***a* to **84***c*, magnetic units **98***a*, **98***b* and **98***c*, which are each made up of a plurality of permanent magnets (and yokes that are not illustrated) placed in a matrix shape with the XY two-dimensional directions serving as a row direction and a column direction, are housed, respectively, so as to correspond to coil units CUs to CUc that guide sections **94***a* and **94***b* of coarse movement stage WCS**1** have. Magnetic unit **98***a* together with coil unit CUa, magnetic unit **98***b* together with coil unit CUb, and magnetic unit **98***c* together with coil unit CUc respectively configure three planar motors by the electromagnetic force (Lorentz force) drive method that are capable of generating drive forces in the X-axis, Y-axis and Z-axis directions, as disclosed in, for example, U.S. Patent Application Publication No. 2003/0085676 and the like, and these three planar motors configure a fine movement stage driving system **64**A (see FIG. **6**) that drives fine movement stage WFS**1** in directions of six degrees of freedom (X, Y, Z, θx, θy and θz).

In wafer stage WST**2** as well, three planar motors composed of coil units that coarse movement stage WCS**2** has and magnetic units that fine movement stage WFS**2** has are configured likewise, and these three planar motors configure a fine movement stage driving system **64**B (see FIG. **6**) that drives fine movement stage WFS**2** in directions of six degrees of freedom (X, Y, Z, θx, θy and θz).

Fine movement stage WFS**1** is movable in the X-axis direction, with a longer stroke compared with the directions of the other five degrees of freedom, along guide members **94***a* and

94*b* arranged extending in the X-axis direction. The same applies to fine movement stage WFS2.

With the configuration as described above, fine movement stage WFS1 is movable in the directions of six degrees of freedom with respect to coarse movement stage WCS1. Further, on this operation, the law of action and reaction (the law of conservation of momentum) that is similar to the previously described one holds owing to the action of a reaction force by drive of fine movement stage WFS1. More specifically, coarse movement stage WCS1 functions as the countermass of fine movement stage WFS1, and coarse movement stage WCS1 is driven in a direction opposite to fine movement stage WFS1. Fine movement stage WFS2 and coarse movement stage WCS2 has the similar relation.

Note that, in the embodiment, when broadly driving fine movement stage WFS1 (or WFS2) with acceleration/deceleration in the X-axis direction (e.g. in the cases such as when a stepping operation between shot areas is performed during exposure), main controller **20** drives fine movement stage WFS1 (or WSF2) in the X-axis direction by the planar motors that configure fine movement stage driving system **64**A (or **64**B). Further, along with this drive, main controller **20** gives the initial velocity, which drives coarse movement stage WCS1 (or WCS2) in the same direction as with fine movement stage WFS1 (or WFS2), to coarse movement stage WCS1 (or WCS2), via coarse movement stage driving system **62**A (or **62**B) (drives coarse movement stage WCS1 (or WCS2) in the same direction as with fine movement stage WCS1 (or WCS2)). This causes coarse movement stage WCS1 (or WCS2) to function as the so-called countermass. Accordingly, it is possible to decrease a movement distance of coarse movement stage WCS1 (or WCS2) in the opposite direction that accompanies the movement of fine movement stage WFS1 (or WFS2) in the X-axis direction (that is caused by a reaction force of the drive force). Especially, in the case where fine movement stage WFS1 (or WFS2) performs an operation including the step movement in the X-axis direction, or more specifically, fine movement stage WFS1 (or WFS2) performs an operation of alternately repeating the acceleration and the deceleration in the X-axis direction, the stroke in the X-axis direction needed fox the movement of coarse movement stage WCS1 (or WCS2) can be the shortest. On this operation, main controller **20** should give coarse movement stage WCS1 (or WCS2) the initial velocity with which the center of gravity of the entire system of wafer stage WST1 (or WST2) that includes the fine movement stage and the coarse movement stage performs constant velocity motion in the X-axis direction. With this operation, coarse movement stage WCS1 (or WCS2) performs a back-and-forth motion within a predetermined range with the position of fine movement stage WFS1 (or WFS2) serving as a reference. Consequently, as the movement stroke of coarse movement stage WCS1 (or WCS2) in the X-axis direction, the distance that is obtained by adding some margin to the predetermined range should be prepared. Such details are disclosed in, for example, U.S. Patent Application Publication No. 2008/0143994 and the like.

Further, as described earlier, since fine movement stage WFS1 is supported at the three noncollinear positions by coarse movement stage WCS1, main controller **20** can tilt fine movement stage WFS1 (i.e. wafer W) at an arbitrary angle (rotational amount) in the θx direction and/or the θy direction with respect to the XY plane by, for example, appropriately controlling a drive force (thrust) in the Z-axis direction that is made to act on each of fine movement slider sections **84***a* to **84***c*. Further, main controller **20** can make the center portion of fine movement stage WFS1 bend in the +Z direction (into a convex shape), for example, by making a drive force in the +θx direction (a counterclockwise direction on the page surface of FIG. **4**B) on each of fine movement slider sections **84***a* and **84***b* and also making a drive force in the −θx direction (a clockwise direction on the page surface of FIG. **45**) on fine movement slider section **84***c*. Further, main controller **20** can also make the center portion of fine movement stage WFS1 bend in the +Z direction (into a convex shape), for example, by making drive forces in the −θy direction and the +θy direction (a counterclockwise direction and a clockwise direction when viewed from the +Y side, respectively) on fine movement slider sections **84***a* and **84***b*, respectively. Main controller **20** can also perform the similar operations with respect to fine movement stage WFS2.

Incidentally, in the embodiment, as fine movement stage driving systems **64**A and **64**B, the planar motors of a moving magnet type are used, but this is not intended to be limiting, and planar motors of a moving coil type in which the coil units are placed at the fine movement slider sections of the fine movement stages and the magnetic units are placed at the guide members of the coarse movement stages can also be used.

Between coupling member **92***a* of coarse movement stage WCS1 and main section **80** of fine movement stage WFS1, as shown in FIG. **4**A, a pair of tubes **86***a* and **86***b* used to transmit the power usage from the outside to fine movement stage WFS1 are installed. Incidentally, although the illustration is omitted in the drawings including FIG. **4**A, actually, the pair of tubes **86***a* and **86***b* are each made up of a plurality of tubes. One ends of tubes **86***a* and **86***b* are connected to the side surface on the +X side of coupling member **92***a* and the other ends are connected to the inside of main section **80**, respectively via a pair of recessed sections **80***a* (see FIG. **4**C) with a predetermined depth each of which is formed from the end surface on the −X side toward the +X direction with a predetermined length, on the upper surface of main section **80**. As shown in FIG. **4**C, tubes **86***a* and **86***b* are configured not to protrude above the upper surface of fine movement stage WFS1. Between coupling member **92***a* of coarse movement stage WCS2 and main section **80** of fine movement stage WFS2 as well, as shown in FIG. **2**, a pair of tubes **86***a* and **86***b* used to transmit the power usage from the outside to fine movement stage WFS2 are installed.

As shown in FIG. **2**, one of the tube carriers, tube carrier TCa is connected to the piping member and the wiring member inside coupling member **92***a* of coarse movement stage WCS1 via tube Ta_2. As shown in FIG. **3**, tube carrier TCa is placed on a stepped section formed at the end on the −X side of base board **12**. Tube carrier TCa is driven in the Y-axis direction following wafer stage WST1, by an actuator such as a liner motor, on the stepped section of base board **12**.

As shown in FIG. **3**, the other of the tube carriers, tube carrier TCb is placed on a stepped section formed at the end on the +X side of base board **12**, and is connected to the piping member and the wiring member inside coupling member **92***a* of coarse movement stage WCS2 via tube Tb_2 (see FIG. **2**). Tube carrier TCb is driven in the Y-axis direction following wafer stage WST2, by an actuator such as a liner motor, on the stepped section of base board **12**.

As shown in FIG. **3**, one ends of tubes Ta_1 and Tb_1 are connected to tube carriers TCa and TCb respectively, while the other ends of tubes Ta_1 and Tb_1 are connected to a power usage supplying device externally installed that is not illustrated (e.g. an electric power supply, a gas tank, a compressor, a vacuum pump or the like). The power usage supplied from the power usage supplying device to tube carrier TCa via tube Ta_1 is supplied to fine movement stage WFS1 via tube Ta_2, the piping member and the wiring member, which are not illustrated, housed in coupling member **92***a* of coarse movement stage WCS**1**, and tubes **86***a* and **86***b*. Similarly, the power usage supplied from the power usage supplying device to tube carrier TCb via tube Tb_1 is supplied to fine movement stage WFS**2** via tube Tb_2, the piping member and the wiring member, which are not illustrated, housed in coupling member **92***a* of coarse movement stage WCS**2**, and tubes **86***a* and **86***b*.

Next, a measurement system that measures positional information of wafer stages WST**1** and WST**2** is described. Exposure apparatus **100** has a fine movement stage position measuring system **70** (see FIG. **6**) to measure positional information of fine movement stages WFS**1** and WFS**2** and coarse movement stage position measuring systems **68**A and **68**B (see FIG. **6**) to measure positional information of coarse movement stages WCS**1** and WCS**2** respectively.

Fine movement stage position measuring system **70** has a measurement bar **71** shown in FIG. **1**. Measurement bar **71** is placed below first sections **14**A_1 and **14**B_1 that the pair of surface plates **14**A and **14**B respectively have, as shown in FIG. **3**. As is obvious from FIGS. **1** and **3**, measurement bar **71** is made up of a beam-like member having a rectangular sectional shape with the Y-axis direction serving as its longitudinal direction, and both ends in the longitudinal direction are each fixed to main frame BD in a suspended state via suspended members **74**. More specifically, main frame BD and measurement bar **71** are integrated. Incidentally, in the case where a configuration that does not block the movement of the wafer stages is employed for the beam-like member, the support method of the beam-like member is not limited to the both ends support but one end in the longitudinal direction can be cantilevered. Further, the beam-like member should be placed below base board **12** described earlier. Furthermore, while the beam-like member is supported by main frame BD, the beam-like member can be arranged on the installation surface (such as a floor surface) via a vibration isolating mechanism. In this case, it is preferable to arrange a measurement device that measures the relative positional relation between main frame BD and the beam-like member. The beam-like member can also be referred to as a member for measurement or the like.

The +Z side half (upper half) of measurement bar **71** is placed between second section **14**A_2 of surface plate **14**A and second section **14**B_2 of surface plate **14**B, and the −Z side half (lower half) is housed inside recessed section **12***a* formed at base board **12**. Further, a predetermined clearance is formed between measurement bar **71** and each of surface plates **14**A and **14**B and base board **12**, and measurement bar **71** is in a state mechanically noncontact with the members other than main frame BD. Measurement bar **71** is formed by a material with a relatively low coefficient of thermal expansion (e.g. Inver, ceramics, or the like).

At measurement bar **71**, as shown in FIG. **5**, a first measurement head group **72** used when measuring positional information of the fine movement stage (WFS**1** or WFS**2**) located below projection unit PU and a second measurement head group **73** used when measuring positional information of the fine movement stage (WFS**1** or WFS**2**) located below alignment device **99** are arranged. Incidentally, alignment systems AL**1** and AL**2**$_1$ to AL**2**$_4$ are shown in virtual lines (two-dot chain lines) in FIG. **5** in order to make the drawing easy to understand. Further, in FIG. **5**, the reference signs of alignment systems AL**2**$_1$ to AL**2**$_4$ are omitted.

As shown in FIG. **5**, first measurement head group **72** is placed below projection unit PU and includes a one-dimensional encoder head for X-axis direction measurement (hereinafter, shortly referred to as an X head or an encoder head) **75***x*, a pair of one-dimensional encoder heads for Y-axis direction measurement (hereinafter, shortly referred to as Y heads or encoder heads) **75***ya* and **75***yb*, and three Z heads **76***a*, **76***b* and **76***c*.

X head **75***x*, Y heads **75***ya* and **75***yb* and the three Z heads **76***a* to **76***c* are placed in a state where their positions do not vary, inside measurement bar **71**. X head **75***x* is placed on reference axis LV, and Y heads **75***ya* and **75***yb* are placed at the same distance apart from X head **75***x*, on the −X side and the +X side, respectively. In the embodiment, as each of the three encoder heads **75***x*, **75***ya* and **75***yb*, a diffraction interference type head having a configuration in which a light source, a photodetection system (including a photodetector) and various types of optical systems are unitized is used which is similar to the encoder head disclosed in, for example, PCT International Publication No. 2007/083758 (the corresponding U.S. Patent Application Publication No. 2007/0288121) and the like.

When wafer stage WST**1** (or WST**2**) is located directly under projection optical system PL (see FIG. **1**), X head **75***x* and Y heads **75***ya* and **75***yb* each irradiate a measurement beam on grating RG (see FIG. **4**B) placed on the lower surface of fine movement stage WFS**1** (or WFS**2**), via a gap between surface plate **14**A and surface plate **14**B or a light-transmitting section (e.g. an opening) formed at first section **14**A_1 of surface plate **14**A and first section **14**B_1 of surface plate **14**B. Further, X head **75***x* and Y heads **75***ya* and **75***yb* each receive diffraction light from grating RG, thereby obtaining positional information within the XY plane (also including rotational information in the θz direction) of fine movement stage WFS**1** (or WFS**2**). More specifically, an X liner encoder **51** (see FIG. **6**) is configured of X head **75***x* that measures the position of fine movement stage WFS**1** (or WFS**2**) in the X-axis direction using the X diffraction grating that grating RG has. And, a pair of Y liner encoders **52** and **53** (see FIG. **6**) are configured of the pair of Y heads **75***ya* and **75***yb* that measure the position of fine movement stage WFS**1** (or WFS**2**) in the Y-axis direction using the Y diffraction grating of grating RG. The measurement value of each of X head **75***x* and Y heads **75***ya* and **75***yb* is supplied to main controller **20** (see FIG. **6**), and main controller **20** measures (computes) the position of fine movement stage WFS**1** (or WFS**2**) in the X-axis direction using (based on) the measurement value of X head **75***x*, and the position of fine movement stage WFS**1** (or WFS**2**) in the Y-axis direction based on the average value of the measurement values of the pair of Y head **75***ya* and **75***yb*. Further, main controller **20** measures (computes) the position in the θz direction (rotational amount around the Z-axis) of fine movement stage WFS**1** (or WFS**2**) using the measurement value of each of the pair of Y linear encoders **52** and **53**.

In this case, an irradiation point (detection point), on grating RG, of the measurement beam emitted from X head **75***x* coincides with the exposure position that is the center of exposure area IA (see FIG. **1**) on wafer W. Further, a midpoint of a pair of irradiation points (detection points), on grating RG, of the measurement beams respectively emitted from the pair of Y heads **75***ya* and **75***yb* coincides with the irradiation point (detection point), on grating RG, of the measurement beam emitted from X head **75***x*. Main controller **20** computes positional information of fine movement stage WFS**1** (or WFS**2**) in the Y-axis direction based on the average of the measurement values of the two Y heads **75***ya* and **75***yb*. Therefore, the positional information of fine movement stage WFS**1** (or WFS**2**) in the Y-axis direction is substantially measured at the exposure position that is the center of irradiation area (exposure area) IA of illumination light IL irradiated on wafer W. More specifically, the measurement center of X head **75**x and the substantial measurement center of the two Y heads **75**ya and **75**yb coincide with the exposure position. Consequently, by using X linear encoder **51** and Y linear encoders **52** and **53**, main controller **20** can perform measurement of the positional information within the XY plane (including the rotational information in the θz direction) of fine movement stage WFS**1** (or WFS**2**) directly under (on the back side of) the exposure position at all times.

As each of Z heads **76**a to **76**c, for example, a head of a displacement sensor by an optical method similar to an optical pickup used in a CD drive device or the like is used. The three Z heads **76**a to **76**c are placed at the positions corresponding to the respective vertices of an isosceles triangle (or an equilateral triangle). Z heads **76**a to **76**c each irradiate the lower surface of fine movement stage WFS**1** (or WFS**2**) with a measurement beam parallel to the Z-axis from below, and receive reflected light reflected by the surface of the plate on which grating RG is formed (or the formation surface of the reflective diffraction grating). Accordingly, Z heads **76**a to **76**c configure a surface position measuring system **54** (see FIG. **6**) that measures the surface position (position in the Z-axis direction) of fine movement stage WFS**1** (or WFS**2**) at the respective irradiation points. The measurement value of each of the three Z heads **76**a to **76**c is supplied to main controller **20** (see FIG. **6**).

Further, the center of gravity of the isosceles triangle (or the equilateral triangle) whose vertices are at the three irradiation points on grating RG of the measurement beams respectively emitted from the three Z heads **76**a to **76**c coincides with the exposure position that is the center of exposure area IA (see FIG. **1**) on wafer W. Consequently, based on the average value of the measurement values of the three Z heads **76**a to **76**c, main controller **20** can acquire positional information in the Z-axis direction (surface position information) of fine movement stage WFS**1** (or WFS**2**) directly under the exposure position at all times. Further, main controller **20** measures (computes) the rotational amount in the θx direction and the θy direction, in addition to the position in the Z-axis direction, of fine movement stage WFS**1** (or WFS**2**) using (based on) the measurement values of the three Z heads **76**a to **76**c.

Second measurement head group **73** has an X head **77**x that configures an X liner encoder **55** (see FIG. **6**), a pair of Y heads **77**ya and **77**yb that configure a pair of Y linear encoders **56** and **57** (see FIG. **6**), and three Z heads **78**a, **78**b and **78**c that configure a surface position measuring system **58** (see FIG. **6**). The respective positional relations of the pair of Y heads **77**ya and **77**yb and the three Z heads **78**a to **78**c with X head **77**x serving as a reference are similar to the respective positional relations described above of the pair of Y heads **75**ya and **75**yb and the three Z heads **76**a to **76**c with X head **75**x serving as a reference. An irradiation point (detection point), on grating RG, of the measurement beam emitted from X head **77**x coincides with the detection center of primary alignment system AL**1**. More specifically, the measurement center of X head **77**x and the substantial measurement center of the two Y heads **77**ya and **77**yb coincide with the detection center of primary alignment system AL**1**. Consequently, main controller **20** can perform measurement of positional information within the XY plane and surface position information of fine movement stage WFS**2** (or WFS**1**) at the detection center of primary alignment system AL**1** at all times.

Incidentally, while each of X heads **75**x and **77**x and Y heads **75**ya, **75**yb, **77**ya and **77**yb of the embodiment has the light source, the photodetection system (including the photodetector) and the various types of optical systems (none of which are illustrated) that are unitized and placed inside measurement bar **71**, the configuration of the encoder head is not limited thereto. For example, the light source and the photodetection system can be placed outside the measurement bar. In such a case, the optical systems placed inside the measurement bar, and the light source and the photodetection system are connected to each other via, for example, an optical fiber or the like. Further, a configuration can also be employed in which the encoder head is placed outside the measurement bar and only a measurement beam is guided to the grating via an optical fiber placed inside the measurement bar. Further, the rotational information of the wafer in the θz direction can be measured using a pair of the X liner encoders (in this case, there should be one Y linear encoder). Further, the surface position information of the fine movement stage can be measured using, for example, an optical interferometer. Further, instead of the respective heads of first measurement head group **72** and second measurement head group **73**, three encoder heads in total, which include at least one XZ encoder head whose measurement directions are the X-axis direction and the Z-axis direction and at least one YZ encoder head whose measurement directions are the Y-axis direction and the Z-axis direction, can be arranged in the placement similar to that of the X head and the pair of Y heads described earlier.

Incidentally, measurement bar **71** can be divided into a plurality of sections. For example, it is also possible that measurement bar **71** is divided into a section having first measurement head group **72** and a section having second measurement head group **73**, and the respective sections (measurement bars) detect the relative position with main frame BD, with (the measurement reference surface of) main frame BD serving as a reference and perform control such that the positional relation is constant. In this case, a head unit, which includes a plurality of encoder heads and Z heads (surface position measuring system), is arranged at both ends of the respective sections (measurement bars), and the positions in the Z-axis direction and the rotational amount in the θx and θy directions of the respective sections (measurement bars) can be computed.

When wafer stage WST**1** moves between exposure station **200** and measurement station **300** on surface plate **14**A, coarse movement stage position measuring system **68**A (see FIG. **6**) measures positional information of coarse movement stage WCS**1** (wafer stage WST**1**).

As shown in FIG. **2**, coarse movement stage position measuring system **68**A includes an interferometer system that has two Y interferometers **18**YA_1 and **18**YA_2 and three X interferometers **18**XA_1, **18**XA_2 and **18**XA_3. Y interferometer **18**YA_2 is placed on the +Y side of surface plate **14**A. Y interferometer **18**YA_2 irradiates reflection surface **17**Y_2 with a measurement beam and receives a reflected beam from reflection surface **17**Y_2, thereby measuring the Y-position of reflection surface **17**Y_2, or more specifically, the Y-position of wafer stage WST**1**. Y interferometer **18**YA_1 is placed on the −Y side of surface plate **14**A. Similarly to Y interferometer **18**YA_2, for example, as shown in FIGS. **12** and **13**, Y interferometer **18**YA_1 irradiates reflection surface **17**Y_1 with a measurement beam and receives a reflected beam from reflection surface **17**Y_1, thereby measuring the Y-position of wafer stage WST**1**. Y interferometers **18**YA_1 and **18**YA_2 are mainly used when wafer stage WST**1** is located in the −Y side half and the +Y side half, respectively, on surface plate **14**A.

Meanwhile, X interferometers **18**XA_1, **18**XA_2 and **18**XA_3 are placed on the −X side of surface plate **14**A, at a predetermined distance in the Y-axis direction. X interferometer **18**XA_3 irradiates reflection surface **17**X with two measurement beams along an axis (measurement axis) parallel to the X-axis that is orthogonal to optical axis AX of projection optical system PL and reference axis LV, and receives reflected beams from reflection surface **17**X, thereby measuring the X-position and θz rotation (yawing amount) of wafer stage WST**1**. Likewise, X interferometers **18**XA_1 and **18**XA_2 also each irradiate reflection surface **17**X with two measurement beams and receive reflected beams from reflection surface **17**X, thereby measuring the X-position and θz rotation (yawing amount) of wafer stage WST**1**. In this case, the distance between X interferometers **18**XA_1, **18**XA_2 and **18**XA_3 adjacent to each other in the Y-axis direction is set such that any of the X interferometers is surely opposed to reflection surface **17**X of wafer stage WST**1**. Main controller **20** (see FIG. **6**) constantly measures the X-position and θz rotation (yawing amount) of wafer stage WST**1** that moves on surface plate **14**A, using X interferometers **18**XA_1, **18**XA_2 and **18**XA_3 by switching them according to the Y-position of wafer stage WST**1**.

Incidentally, the configuration of coarse movement stage position measuring system **68**A (and coarse movement stage position measuring system **68**B to be described later on) is not limited to the configuration described above, and an encoder system or a combination of an optical interferometer system and an encoder system can also be employed. In the case where coarse movement stage position measuring system **68**A includes the encoder system, for example, a configuration can be employed in which the positional information of coarse movement stage WCS**1** is measured by irradiating a scale (e.g. two-dimensional grating) fixed (or formed) on the upper surface of coarse movement stage WCS**1** with measurement beams from a plurality of encoder heads fixed to main frame BD in a suspended state along the movement course of wafer stage WST**1** and receiving the diffraction light of the measurement beams.

When wafer stage WST**2** moves between exposure station **200** and measurement station **300** on surface plate **14**B, coarse movement stage position measuring system **68**B (see FIG. **6**) measures positional information of coarse movement stage WCS**2** (wafer stage WST**2**), similarly to coarse movement stage position measuring system **68**A.

As shown in FIG. **2**, coarse movement stage position measuring system **68**B includes an interferometer system that has two Y interferometers **18**YB_1 and **18**YB_2 and three X interferometers **18**XB_1, **18**XB_2 and **18**XB_3. Y interferometer **18**YB_1 is placed on the side of surface plate **14**B. Y interferometer **18**YB_1 irradiates reflection surface **17**Y_1 with a measurement beam and receives a reflected beam from reflection surface **17**Y_1, thereby measuring the Y-position of reflection surface **17**Y_1, or more specifically, the Y-position of wafer stage WST**2**. Y interferometer **18**YB_2 is placed on the +Y side of surface plate **14**B. Similarly to Y interferometer **18**YB_1, for example, when wafer stage WST**2** is located at the position as shown in FIGS. **12** and **13**, Y interferometer **18**YB_2 irradiates reflection surface **17**Y_2 with a measurement beam and receives a reflected beam from reflection surface **17**Y_2, thereby measuring the Y-position of wafer stage WST**2**. Y interferometers **18**YB_1 and **18**YB_2 are mainly used when wafer stage WST**2** is located in the −Y side half and the +Y side half, respectively, on surface plate **14**B.

Meanwhile, X interferometers **18**XB_1, **18**XB_2 and **18**XB_3 are placed on the +X side of surface plate **14**B, at a predetermined distance in the Y-axis direction. X interferometer **18**XB_3 irradiates reflection surface **17**X with two measurement beams along an axis (measurement axis) parallel to the X-axis that is orthogonal to optical axis AX of projection optical system PL and reference axis LV, and receives reflected beams from reflection surface **17**X, thereby measuring the X-position and θz rotation (yawing amount) of wafer stage WST**2**. Likewise, X interferometers **18**XB_1 and **18**XB_2 also each irradiate reflection surface **17**X with two measurement beams and receive reflected beams from reflection surface **17**X, thereby measuring the X-position and θz rotation (yawing amount) of wafer stage WST**2**. In this case, the distance between X interferometers **18**XB_1, **18**XB_2 and **18**XB_3 adjacent to each other in the Y-axis direction is set such that any of the X interferometers is surely opposed to reflection surface **17**X of wafer stage WST**2**. Main controller **20** (see FIG. **6**) constantly measures the X-position and θz rotation (yawing amount) of wafer stage WST**2** that moves on surface plate **14**B, using X interferometers **18**XB_1, **18**XB_2 and **18**XB_3 by switching them according to the Y-position of wafer stage WST**2**.

As is obvious from FIG. **2**, each of Y interferometers **18**YA_1 and **18**YA_2 and X interferometers **18**XA_1, **18**XA_2 and **18**XA_3 that configure coarse movement stage position measuring system **68**A is placed symmetric with each of Y interferometers **18**YB_1 and **18**YB_2 and X interferometers **18**XB_1, **18**XB_2 and **18**XB_3 that configure a part of coarse movement stage position measuring system **68**B, with respect to reference axis LV.

Main controller **20** respectively controls the positions of coarse movement stages WCS**1** and WCS**2** (wafer stages WST**1** and WST**2**) by individually controlling coarse movement stage driving systems **62**A and **62**B, based on the measurement values of coarse movement stage position measuring systems **68**A and **68**B.

Further, exposure apparatus **100** is also equipped with a relative position measuring system **66**A and a relative position measuring system **66**B (see FIG. **6**) that measure the relative position between coarse movement stage WCS**1** and fine movement stage WFS**1** and the relative position between coarse movement stage WCS**2** and fine movement stage WFS**2**, respectively. While the configuration of relative position measuring systems **66**A and **66**B is not limited in particular, relative position measuring systems **66**A and **66**B can each be configured of, for example, a gap sensor including a capacitance sensor. In this case, the gap sensor can be configured of, for example, a probe section fixed to coarse movement stage WCS**1** (or WCS**2**) and a target section fixed to fine movement stage WFS**1** (or WFS**2**). Incidentally, the configuration of the relative position measuring system is not limited thereto, but for example, the relative position measuring system can be configured using, for example, a liner encoder system, an optical interferometer system or the like.

FIG. **6** shows a block diagram that shows input/output relations of main controller **20** that is configured of a control system of exposure apparatus **100** as the central component and performs overall control of the respective components. Main controller **20** includes a workstation (or a microcomputer) and the like, and performs overall control of the respective components of exposure apparatus **100** such as local liquid immersion device B, surface plate driving systems **60**A and **60**B, coarse movement stage driving systems **62**A and **62**B, and fine movement stage driving systems **64**A and **64**B.

Next, a parallel exposure operation using the two wafer stages WST**1** and WST**2** is described with reference to FIGS. **7** to **13**. Note that during the exposure operation, main controller **20** controls liquid supply device **5** and liquid recovery device **6** as described earlier and a constant quantity of liquid Lq is held directly under tip lens **191** of projection optical system PL, and thereby a liquid immersion area is formed at all times.

FIG. **7** shows a state where exposure by a step-and-scan method is performed on wafer W mounted on fine movement stage WFS**1** of wafer stage WST**1** in exposure station **200**, and in parallel with this exposure, wafer exchange is performed between a wafer carrier mechanism (not illustrated) and fine movement stage WFS**2** of wafer stage WST**2** at the second loading position.

Main controller **20** performs the exposure operation by a step-and-scan method by repeating an inter-shot movement (stepping between shots) operation of moving wafer stage WST**1** to a scanning starting position (acceleration starting position) for exposure of each shot area on wafer W, based on the results of wafer alignment (e.g. information obtained by converting an arrangement coordinate of each shot area on wafer W obtained by an Enhanced Global Alignment (EGA) into a coordinate with the second fiducial mark on measurement plate FM**1** serving as a reference) and reticle alignment and the like that have been performed beforehand, and a scanning exposure operation of transferring a pattern formed on reticle R onto each shot area on wafer W by a scanning exposure method. During this step-and-scan operation, surface plates **14**A and **14**B exert the function as the countermasses, as described previously, according to movement of wafer stage WST**1**, for example, in the Y-axis direction during scanning exposure. Further, main controller **20** gives the initial velocity to coarse movement stage WCS**1** when driving fine movement stage WFS**1** in the X-axis direction for the stepping operation between shots, and thereby coarse movement stage WCS**1** functions as a local countermass with respect to fine movement stage WFS**1**. Consequently, the movement of wafer stage WST**1** (coarse movement stage WCS**1** and fine movement stage WFS**1**) does not cause vibration of surface plates **14**A and **14**B and does not adversely affect wafer stage WST**2**.

The exposure operations described above are performed in a state where liquid Lq is held in the space between tip lens **191** and wafer W (wafer W and plate **82** depending on the position of a shot area), or more specifically, by liquid immersion exposure.

In exposure apparatus **100** of the embodiment, during a series of the exposure operations described above, main controller **20** measures the position of fine movement stage WFS**1** using first measurement head group **72** of fine movement stage position measuring system **70** and controls the position of fine movement stage WFS**1** (wafer W) based on this measurement result.

The wafer exchange is performed by unloading a wafer that has been exposed from fine movement stage WFS**2** and loading a new wafer onto fine movement stage WFS**2** by the wafer carrier mechanism that is not illustrated, when fine movement stage WFS**2** is located at the second loading position. In this case, the second loading position is a position where the wafer exchange is performed on wafer stage WST**2**, and in the embodiment, the second loading position is to be set at the position where fine movement stage WFS**2** (wafer stage WST**2**) is located such that measurement plate FM**2** is positioned directly under primary alignment system AL**1**.

During the wafer exchange described above, and after the wafer exchange, while wafer stage WST**2** stops at the second loading position, main controller **20** executes reset (resetting of the origin) of second measurement head group **73** of fine movement stage position measuring system **70**, or more specifically, encoders **55**, **56** and **57** (and surface position measuring system **58**), prior to start of wafer alignment (and the other pre-processing measurements) with respect to the new wafer W.

When the wafer exchange (loading of the new wafer w) and the reset of encoders **55**, **56** and **57** (and surface position measuring system **58**) have been completed, main controller **20** detects the second fiducial mark on measurement plate FM**2** using primary alignment system AL**1**. Then, main controller **20** detects the position of the second fiducial mark with the index center of primary alignment system AL**1** serving as a reference, and based on the detection result and the result of position measurement of fine movement stage WFS**2** by encoders **55**, **56** and **57** at the time of the detection, computes the position coordinate of the second fiducial mark in an orthogonal coordinate system (alignment coordinate system) with reference axis La and reference axis LV serving as coordinate axes.

Next, as shown in FIG. **8**, main controller **20** performs the EGA while measuring the position coordinate of fine movement stage WFS**2** (wafer stage WST**2**) in the alignment coordinate system using encoders **55**, **56** and **57** (see FIG. **6**). To be more specific, as disclosed in, for example, U.S. Patent Application Publication No. 2008/0088843 and the like, main controller **20** moves wafer stage WST**2**, or more specifically, coarse movement stage WCS**2** that supports fine movement stage WFS**2** in, for example, the Y-axis direction. Then, main controller **20** sets the position of fine movement stage WFS**2** at a plurality of positions in the movement course, and at each position setting, detects the position coordinates, in the alignment coordinate system, of alignment marks at alignment shot areas (sample shot areas) using at least one of alignment systems AL**1** and AL**2**$_2$ and AL**2**$_4$.

In this case, in conjunction with the movement operation of wafer stage WST**2** in the Y-axis direction described above, alignment systems AL**1** and AL**2**$_2$ to AL**2**$_4$ respectively detect a plurality of alignment marks (sample marks) disposed along the X-axis direction that are sequentially placed within the detection areas (e.g. corresponding to the irradiation areas of detection light). Therefore, on the measurement of the alignment marks described above, wafer stage WST**2** is not driven in the X-axis direction.

Then, based on the position coordinates of the plurality of alignment marks arranged at the sample shot areas on wafer W and the design position coordinates, main controller **20** executes statistical computation (EGA computation) disclosed in, for example, U.S. Pat. No. 4,780,617 and the like, and computes the position coordinates (arrangement coordinates) of the plurality of shot areas in the alignment coordinate system.

Further, in exposure apparatus **100** of the embodiment; since measurement station **300** and exposure station **200** are spaced apart, main controller **20** subtracts the position coordinate of the second fiducial mark that has previously been detected from the position coordinate of each of the shot areas on wafer W that has been obtained as a result of the wafer alignment, thereby obtaining the position coordinates of the plurality of shot areas on wafer W with the position of the second fiducial mark serving as the origin.

Normally, the above-described wafer exchange and wafer alignment sequence is completed earlier than the exposure sequence. Therefore, when the wafer alignment has been completed, main controller **20** drives wafer stage WST**2** in the +X direction to move wafer stage WST**2** to a predetermined standby position on surface plate **14**B, as shown in FIG. **9**. In this case, when wafer stage WST**2** is driven in the +X direction, fine movement stage WFS goes out of a measurable range of fine movement stage position measuring system **70** (i.e. the measurement beams emitted from second measurement head group **73** move off from grating RG). Therefore, based on the measurement values of fine movement stage position measuring system **70** (encoders **55**, **56** and **57**) and the measurement values of relative position measuring system **66**B, main controller **20** measures the position of coarse movement stage WCS**2** using coarse movement stage position measuring system **68**B, and based on the measurement result, controls the position of wafer stage WST**2**. More specifically, position measurement of wafer stage WST**2** within the XY plane is switched from the measurement using encoders **55**, **56** and **57** of fine movement stage position measuring system **70** to the measurement using Y interferometer **18**YB_1 and X interferometer **18**XB_1 of coarse movement stage position measuring system **68**B. Then, main controller **20** makes wafer stage WST**2** wait at the predetermined standby position described above until exposure on wafer W on fine movement stage WFS**1** is completed.

When the exposure on wafer W on fine movement stage WFS**1** has been completed, main controller **20** starts to drive wafer stages WST**1** and WST**2** severally toward a right-side scrum position shown in FIG. **10**. When wafer stage WST**1** is driven in the −X direction toward the right-side scrum position, fine movement stage WFS**1** goes out of the measurable range of fine movement stage position measuring system **70** (encoders **51**, **52** and **53** and surface position measuring system **54**) (i.e. the measurement beams emitted from first measurement head group **72** move off from grating RG). Therefore, main controller **20** measures the position of coarse movement stage WCS**1** using coarse movement stage position measuring system **68**A, and based on the measurement result, controls the position of wafer stage WST**1**. More specifically, main controller **20** switches position measurement of wafer stage WST**1** within the XY plane from the measurement using encoders **51**, **52** and **53** of fine movement stage position measuring system **70** to the measurement using Y interferometer **18**YA_2 and X interferometer **18**XA_3 of coarse movement stage position measuring system **68**A.

Further, main controller **20** measures the position of wafer stage WST**2** using coarse movement stage position measuring system **68**B, and based an the measurement result, as shown in FIG. **9**, drives wafer stage WST**2** in the +Y direction on surface plate **14**B (see an outlined arrow in FIG. **9**). On this operation, as shown in FIGS. **9** and **10**, the X interferometer used in the position measurement of wafer stage WST**2** is sequentially switched to X interferometers **18**XB_1, **18**XB_2 and **18**XB_3 according to the Y-position of wafer stage WST**2**, and also the Y interferometer used in the position measurement of wafer stage WST**2** is switched from Y interferometer **18**YB_1 to Y interferometer **18**YB_2. Note that surface plate **14**B functions as the countermass owing to the action of a reaction force of a drive force of wafer stage WST**2**.

Further, in parallel with the movement of wafer stages WST**1** and WST**2** toward the right-side scrum position described above, main controller **20** drives fine movement stage WFS**1** in the +X direction based on the measurement values of relative position measuring system **66**A and causes fine movement stage WFS**1** to be in proximity to or in contact with coarse movement stage WCS**1**, and also drives fine movement stage WFS**2** in the −X direction based on the measurement values of relative position measuring system **66**B and causes fine movement stage WFS**2** to be in proximity to or in contact with coarse movement stage WCS**2**.

Then, in a state where both wafer stages WST**1** and WST**2** have moved to the right-side scrum position, wafer stage WST**1** and wafer stage WST**2** go into a scrum state of being in proximity or in contact in the X-axis direction, as shown in FIG. **10**. Simultaneously with this state, fine movement stage WFS**1** and coarse movement stage WCS**1** go into a scrum state, and coarse movement stage WCS**2** and fine movement stage WFS**2** go into a scrum state. Then, the upper surfaces of fine movement stage WFS**1**, coupling member **92***b* of coarse movement stage WCS**1**, coupling member **92***b* of coarse movement stage WCS**2** and fine movement stage WFS**2** form a fully flat surface that is apparently integrated.

As shown in FIG. **10**, while keeping the scrum states described above, main controller **20** drives wafer stage WST**1** in a direction indicated by a black arrow (−X direction) based on the measurement result of coarse movement stage position measuring system **68**A, and at the same time, drives wafer stage WST**2** in a direction indicated by an outlined arrow (−X direction) based on the measurement result of coarse movement stage position measuring system **68**B. As wafer stages WST**1** and WST**2** move in the −X direction while keeping the three scrum states described above, the liquid immersion area (liquid Lq) formed between tip lens **191** and fine movement stage WFS**1** sequentially moves onto fine movement stage WFS**1**, coupling member **92***b* of coarse movement stage WCS**1**, coupling member **92***b* of coarse movement stage WCS**2**, and fine movement stage WFS**2**. FIG. **10** shows a state just before starting the movement of the liquid immersion area (liquid Lq). Note that in the case where wafer stage WST**1** and wafer stage WST**2** are driven while the above-described three scrum states are kept, it is preferable that a gap (clearance) between wafer stage WST**1** and wafer stage WST**2**, a gap (clearance) between fine movement stage WFS**1** and coarse movement stage WCS**1** and a gap (clearance) between coarse movement stage WCS**2** and fine movement stage WFS**2** are set such that leakage of liquid Lq is prevented or restrained. In this case, the proximity includes the case where the gap (clearance) between the two members in the scrum state is zero, or more specifically, the case where both the members are in contact.

After the liquid immersion area (liquid Lq) has been moved onto fine movement stage WFS**2**, main controller **20** drives fine movement stage WFS**1** in the −X direction based on the measurement value of relative position measuring system **66**A and releases the scrum state of fine movement stage WFS**1** and coarse movement stage WCS**1**, and also drives fine movement stage WFS**2** in the +X direction based on the measurement value of relative position measuring system **66**B and release the scrum state of fine movement stage WFS**2** and coarse movement stage WCS**2**. Furthermore, main controller **20** releases the scrum state of wafer stages WST**1** and WST**2**.

When the movement of the liquid immersion area (liquid Lq) onto fine movement stage WFS**2** has been completed, wafer stage WST**1** has moved onto surface plate **14**A. Then, main controller **20** moves wafer stage WST**1** in the −Y direction on surface plate **14**A as shown by a black arrow in FIG. **11** and further moves wafer stage WST**1** in the +X direction as shown in FIG. **12**, while measuring the position of wafer stage WST**1** using coarse movement stage position measuring system **68**A, so as to move wafer stage WST**1** to the first loading position. On this operation, as shown in FIGS. **11** and **12**, the X interferometer used in the position measurement of wafer stage WST**1** is sequentially switched to X interferometers **18**XA_3, **18**XA_2 and **18**XA_1 according to the Y-position of wafer stage WST**1**, and also the Y interferometer used in the position measurement of wafer stage WST**1** is switched from Y interferometer **18**YA_2 to Y interferometer **18**YA_1. Note that, when wafer stage WST**1** moves in the −Y direction, surface plate **14**A functions as the countermass owing to the action of a reaction force of the drive force. Further, when wafer stage WST**1** moves in the +X direction, surface plate **14**A can be made to function as the countermass owing to the action of a reaction force of the drive force.

As shown in FIG. **13**, after wafer stage WST**1** has reached the first loading position, main controller **20** switches position measurement of wafer stage WST**1** within the XY plane from the measurement using coarse movement stage position measuring system **68**A to the measurement using fine movement stage position measuring system **70** (encoders **55**, **56** and **57** included in second measurement head group **73**).

In parallel with the movement of wafer stage WST**1** described above, main controller **20** drives wafer stage WST**2** and sets the position of measurement plate FM**2** at directly under projection optical system PL, as shown in FIG. **12**. Prior to this operation, main controller **20** has switched position measurement of wafer stage WST**2** within the XY plane from the measurement using coarse movement stage position measuring system **68**B to the measurement using fine movement stage position measuring system **70** (encoders **51**, **52** and **53**). Then, the pair of first fiducial marks on measurement plate FM**2** are detected using reticle alignment systems RA_1 and RA_2 and the relative position of projected images, on the wafer, of the reticle alignment marks on reticle R that correspond to the first fiducial marks are detected. Note that this detection is performed via projection optical system PL and liquid Lq that forms the liquid immersion area.

Based on the relative positional information detected as above and the positional information of each of the shot areas on wafer W with the second fiducial mark on fine movement stage WFS**2** serving as a reference that has been previously obtained, main controller **20** computes the relative positional relation between the projection position of the pattern of reticle R (the projection center of projection optical system PL) and each of the shot areas on wafer W mounted on fine movement stage WFS**2**. While controlling the position of fine movement stage WFS**2** (wafer stage WST**2**) based on the computation results, main controller **20** transfers the pattern of reticle R onto each shot area on wafer W mounted on fine movement stage WFS**2** by a step-and-scan method, which is similar to the case of wafer W mounted on fine movement stage WFS**1** described earlier. FIG. **13** shows a state where the pattern of reticle R is transferred onto each shot area on wafer W in this manner.

In parallel with the above-described exposure operation on wafer W on fine movement stage WFS**2**, main controller **20** performs the wafer exchange between the wafer carrier mechanism (not illustrated) and wafer stage WST**1** at the first loading position and mounts a new wafer W on fine movement stage WFS**1**. In this case, the first loading position is a position where the wafer exchange is performed on wafer stage WST**1**, and in the embodiment, the first loading position is to be set at the position where fine movement stage WFS**1** (wafer stage WST**1**) is located such that measurement plate FM**1** is positioned directly under primary alignment system AL**1**.

Then, main controller **20** detects the second fiducial mark on measurement plate FM**1** using primary alignment system AL**1**. Note that, prior to the detection of the second fiducial mark, main controller **20** executes reset (resetting of the origin) of second measurement head group **73** of fine movement stage position measuring system **70**, or more specifically, encoders **55**, **56** and **57** (and surface position measuring system **58**), in a state where wafer stage WST**1** is located at the first loading position. After that, main controller **20** performs wafer alignment (EGA) using alignment systems AL**1** and $AL2_1$ to $AL2_4$, which is similar to the above-described one, with respect to wafer W on fine movement stage WFS**1**, while controlling the position of wafer stage WST**1**.

When the wafer alignment (EGA) with respect to wafer W on fine movement stage WFS**1** has been completed and also the exposure on wafer W on fine movement stage WFS**2** has been completed, main controller **20** drives wafer stages WST**1** and WST**2** toward a left-side scrum position. This left-side scrum, position indicates a positional relation in which wafer stages WST**1** and WST**2** are located at positions that are bilaterally symmetric with the positions of the wafer stages in the right-side scrum position shown in FIG. **10**, with respect to reference axis LV described above. Measurement of the position of wafer stage WST**1** during the drive toward the left-side scrum position is performed in a similar procedure to that of the position measurement of wafer stage WST**2** described earlier.

At this left-side scrum position as well, wafer stage WST**1** and wafer stage WST**2** go into the scrum state described earlier, and concurrently with this state, fine movement stage WFS**1** and coarse movement stage WCS**1** go into the scrum state and coarse movement stage WCS**2** and fine movement stage WFS**2** go into the scrum state. Then, the upper surfaces of fine movement stage WFS**1**, coupling member **92***b* of coarse movement stage WCS**1**, coupling member **92***b* of coarse movement stage WCS**2** and fine movement stage WFS**2** form a fully flat surface that is apparently integrated.

Main controller **20** drives wafer stages WST**1** and WST**2** in the +X direction that is reverse to the previous direction, while keeping the three scrum states described above. According this drive, the liquid immersion area (liquid Lq) formed between tip lens **191** and fine movement stage WFS**2** sequentially moves onto fine movement stage WFS**2**, coupling member **92***b* of coarse movement stage WCS**2**, coupling member **92***b* of coarse movement stage WCS**1** and fine movement stage WFS**1**, which is reverse to the previously described order. As a matter of course, also when the wafer stages are moved while the scrum states are kept, the position measurement of wafer stages WST**1** and WST**2** is performed, similarly to the previously described case. When the movement of the liquid immersion area (liquid Lq) has been completed, main controller **20** starts exposure on wafer W on wafer stage WST**1** in the procedure similar to the previously described procedure. In parallel with this exposure operation, main controller **20** drives wafer stage WST**2** toward the second loading position in a manner similar to the previously described manner, exchanges wafer W that has been exposed on wafer stage WST**2** with a new wafer W, and executes the wafer alignment with respect to the new wafer W.

After that, main controller **20** repeatedly executes the parallel processing operations using wafer stages WST**1** and WST**2** described above.

As described above, in exposure apparatus **100** of the embodiment, during the exposure operation and during the wafer alignment (mainly, during the measurement of the alignment marks), first measurement head group **72** and second measurement head group **73** fixed to measurement bar **71** are respectively used in the measurement of the positional information (the positional information within the XY plane and the surface position information) of fine movement stage WFS**1** (or WFS**2**) that holds wafer W. And, since encoder heads **75***x*, **75***ya* and **75***yb* and Z heads **76***a* to **76***c* that configure first measurement head group **72**, and encoder heads **77***x*, **77***ya* and **77***yb* and Z heads **78***a* to **78***c* that configure second measurement head group **73** can respectively irradiate grating RG placed on the bottom surface of fine movement stage WFS**1** (or WFS**2**) with measurement beams from directly below at the shortest distance, measurement error caused by temperature fluctuation of the surrounding atmosphere of wafer stage WST**1** or WST**2**, e.g., air fluctuation is reduced, and high-precision measurement of the positional information of fine movement stage WFS can be performed.

Moreover, in exposure apparatus **100** of the embodiment, when the liquid immersion area (liquid Lq) formed on one of wafer stages WST**1** and WST**2** is moved onto the other of wafer stages WST**1** and WST**2**, positional information of one of the wafer stages is measured by first measurement head group **72** of fine movement stage position measuring system **70** and positional information of the other of the wafer stages or both the wafer stages is measured by coarse movement stage position measuring systems **68**A and **68**S. Wafer stages WST**1** and WST**2** are driven while the serum state of being in proximity to each other is maintained based on the measurement result, and thereby the liquid immersion area (liquid Lq) formed on one of the wafer stages can be moved to the other of the wafer stages.

Further, exposure apparatus **100** of the embodiment is equipped with fine movement stage position measuring system **70** (first and second measurement head groups **72** and **73**) that measures positional information of fine movement stages WFS**1** and WFS**2** that move between exposure station **200** (below projection unit PU) and measurement station **300** (below alignment device **99**), and coarse movement stage position measuring systems **68**A and **68**B that measure positional information of coarse movement stages WCS**1** and WCS**2** that move between exposure station **200** and measurement station **300**. Accordingly, based on the measurement results of fine movement stage position measuring system **70** and coarse movement stage position measuring systems **68**A and **68**B, wafer stages WST**1** and WST**2** can be moved between exposure station **200** and measurement station **300**.

Further, according to exposure apparatus **100** of the embodiment, based on the measurement results of fine movement stage position measuring system **70** (first measurement head group **72**) and coarse movement stage position measuring systems **68**A and **68**B, main controller **20** causes coarse movement stages WCS**1** and WCS**2** and fine movement stages WFS**1** and WFS**2**, which wafer stages WST**1** and WST**2** respectively have, to be in proximity (or be in contact) in the X-axis direction, and also causes wafer stages WST**1** and WST**2** to be in proximity (or be in contact) in the X-axis direction, and moves wafer stages WST**1** and WST**2** integrally in the X-axis direction while maintaining the proximity states. Accordingly, the liquid immersion area (liquid Lq) formed on one of wafer stages WST**1** and WST**2** can be moved onto the other of wafer stages WST**1** and WST**2**.

Incidentally, in the embodiment above, the liquid immersion area (liquid Lq) is moved between fine movement stage WFS**1** and fine movement stage WFS**2** via coupling members **92***b* which coarse movement stages WCS**1** and WCS**2** are respectively equipped with. In the case where coupling members **92***b* are not necessary in terms of the configuration of coarse movement stages WCS**1** and WCS**2**, or more specifically, in the case where coarse movement stages WCS**1** and WCS**2** are configured into a U-like shape by coupling the pair of coarse movement slider sections **90***a* and **90***b* using only coupling member **92***a* as in a modified example shown in FIG. **14**, the liquid immersion area (liquid Lq) can be directly moved between fine movement stage WFS**1** and fine movement stage WFS**2**. FIG. **14** shows the state where bath wafer stages WST**1** and WST**2** corresponding to the state shown in FIG. **10** have moved to the right-side scrum position.

In this modified example of FIG. **14**, in parallel with movement of wafer stages WST**1** and WST**2** toward the right-side scrum position, main controller **20** drives fine movement stage WFS**1** in the +X direction with respect to coarse movement stage WCS**1** based on the measurement value of relative position measuring system **66**A and also drives fine movement stage WFS**2** in the −X direction with respect to coarse movement stage WCS**2** based on the measurement value of relative position measuring system **66**B. Then, when both wafer stages WST**1** and WST**2** have moved to the right-side scrum position, as shown in FIG. **14**, fine movement stage WFS**1** and fine movement stage WFS**2** go into a scrum state of being in proximity or in contact in the X-axis direction. At this point in time, the upper surfaces of fine movement stage WFS**1** and fine movement stage WFS**2** form a fully flat surface that is apparently integrated. Main controller **20** drives wafer stage WST**1** in the −X direction as indicated by a black arrow based on the measurement result of coarse movement stage position measuring system **68**A while keeping the scrum state, and at the same time, drives wafer stage WST**2** in the −X direction as indicated by an outlined arrow based on the measurement result of coarse movement stage position measuring system **68**B. According to movement of both wafer stages WST**1** and WST**2**, the liquid immersion area (liquid Lq) formed between tip lens **191** and fine movement stage WFS**1** moves onto fine movement stage WFS**2**.

Second Embodiment

A second embodiment of the present invention is described below with reference to FIGS. **15** to **23**. Herein, for the components that are the same as or equivalent to those in the first embodiment described above, the same or similar reference signs are used and the description thereof is omitted or simplified.

FIG. **15** shows a plan view of an exposure apparatus **1000** of the present second embodiment. As is obvious when comparing FIG. **15** and FIG. **2**, although exposure apparatus **1000** of the present second embodiment is much different in the configuration of a wafer stage that holds wafer W from exposure apparatus **100** of the first embodiment described earlier, the configuration of the other sections is substantially similar. Therefore, in the description below, the different point is focused on and described from the viewpoint of preventing the redundant description.

FIG. **16**A shows a plan view of a wafer stage WST**3** which exposure apparatus **1000** is equipped with, and FIG. **16**B shows a cross sectional view taken along the line B-B of FIG. **16**A. Wafer stage WST**3** is a tabular member as a whole that is made up of a member **180** corresponding to the fine movement stage in the first embodiment described earlier (a tabular member that holds wafer W on its upper surface and has grating RG on its lower surface) that is integrally fixed to a member **190** with a rectangular frame shape in a planar view corresponding to the coarse movement stage. At ends on the +Y side and the −Y side of wafer stage WST**3**, magnetic units **196***a* and **196***b* are arranged that configure, together with coil units (the illustration is omitted) respectively inside first sections **14**A_1 and **14**B_1 of surface plates, **14**A and **14**B, a planar motor of a magnetic levitation type that is capable of generating a thrust in the directions of six degrees of freedom. Wafer stage WST**3** is driven by this planar motor so as to follow the XY plane on the surface plates. More specifically, the planar motor functions as stage driving systems **61**A and **61**B (see FIG. **18**) in both coarse and fine movements. Incidentally, in this case as well, the planar motor can be of a moving magnet type or a moving coil type, and either type can be applied.

The −X side section of member **190** that configures the end on the −X side of wafer stage WST**3** is formed so as to be hollow, similar to coupling member **92***a* in the first embodiment described earlier, and inside member **190**, a piping member, a wiring member and the like, which are not illustrated, used to supply the power usage to wafer stage WST**3** are housed. Further, inside wafer stage WST**3**, various types of optical members (e.g. an aerial image measuring instrument, an uneven illuminance measuring instrument, an illuminance monitor, a wavefront aberration measuring instrument and the like) can be housed.

Further, the mirror polishing is applied to each of the side surface on the +Y side, the side surface on the −Y side and the side surface on the −X side of wafer stage WST**3**, and reflection surfaces **17**Y_2, **17**Y_1 and **17**X are formed. These reflection surfaces are used in position measurement of wafer stage WST**3** by interferometer systems **67**A and **67**B that are described later. Instead of reflection surfaces **17**Y_2, **17**Y_1 and **17**X, a movable mirror made up of a planar mirror can be arranged at wafer stage WST**3**.

As is obvious from FIG. **15**, a wafer stage WST**4** is configured similar to wafer stage WST**3** including the drive systems and the position measurement systems, except that wafer stage WST**4** is placed in a state mirror-reversed with respect to wafer stage WST**3**.

Next, a measurement system that measures positional information of wafer stages WST**3** and WST**4** is described. Exposure apparatus **1000** is equipped with a stage position measuring system **70** (see FIG. **18**) that measures positional information of wafer stages WST**3** and WST**4** in exposure station **200** (below projection unit ET) and in measurement station **300** (below alignment device **99**) and an auxiliary stage position measuring system **79** and interferometer systems **67**A and **67**B (see FIG. **18**) that measure positional information of wafer stages WST**3** and WST**4** in areas on surface plates **14**A and **14**B other than exposure station **200** and measurement station **300**.

Stage position measuring system **70** is configured substantially similar to fine movement stage position measuring system **70** in the first embodiment. More specifically, as shown in FIG. **17**, at measurement bar **71** that is placed below surface plates **14**A and **14**B (first sections **14**A_1 and **14**B_1), first measurement head group **72** and second measurement head group **73** are arranged. First and second measurement head groups **72** and **73** are placed below projection unit PU and alignment device **99** respectively, and are used to measure positional information of wafer stages WST**3** and WST**4** located in exposure station **200** and measurement station **300**.

Auxiliary stage position measuring system **79** is used to measure positional information of wafer stages WST**3** and WST**4** located in an area (hereinafter, referred to as a scrum area for the sake of convenience) between exposure station **200** and measurement station **300**. Auxiliary stage position measuring system **79** includes a third measurement head group **79**H arranged at measurement bar **71**.

As shown in FIG. **17**, third measurement head group **79**H placed between first measurement head group **72** and second measurement head group **73**, and includes an X head **79***x* and a pair of Y heads **79***ya* and **79***yb*. X head **79***x* is placed on reference axis LV and Y heads **79***ya* and **79***yb* are placed at the same distance apart from X head **79***x*, on the −X side and the +X side, respectively. As each of theses X head **79***x* and Y heads **79***ya* and **79***yb*, a diffraction interference type head that is similar to the above-described one is used.

When wafer stage WST**3** or WST**4** is located in the scrum area, X head **79***x* and Y heads **79***ya* and **79***yb* each measure the X-position information or the Y-position information of wafer stage WST**3** or WST**4**, by irradiating a measurement beam on grating RG (see FIG. **16**B) placed on the lower surface of wafer stage WST**3** or WST**4**, via a gap between surface plate **14**A and surface plate **14**B or a light-transmitting section (e.g. an opening) formed at first section **14**A_1 of surface plate **14**A and first section **14**B_1 of surface plate **14**B and receiving diffraction light from grating RG.

The measurement value of each of X head **79***x* and Y heads **79***ya* and **79***yb* included in third, measurement head group **79**H is supplied to main controller **20** (see FIG. **18**). Main controller **20** computes the X-position, Y-position and θz rotation of wafer stage WST**3** or WST**4** based on the measurement value of X head **79***x*, the average value of the measurement values of the pair of Y heads **79***ya* and **79***yb*, and the difference between the measurement values of Y heads **79***ya* and **79***yb*, respectively.

In this case, the separation distance in the Y-axis direction between third measurement head group **79**H and each of first measurement head group **72** and second measurement head group **73** is set less than the width in the Y-axis direction of grating RG arranged on wafer stage WST**3** or WST**4**. Therefore, simultaneously with heads **75***x*, **75***ya* and **75***yb* included in first measurement head group **72** irradiating grating RG with measurement beams, head **79***x*, **79***ya* and **79***yb* included in third measurement head group **79**H can also irradiate grating RG with measurement beams. Likewise, simultaneously with heads **77***x*, **77***ya* and **77***yb* included in second measurement head group **73** irradiating grating RG with measurement beams, head **75***x*, **75***ya* and **75***yb* included in third measurement head group **79**H can also irradiate grating n with measurement beams. Consequently, when wafer stages WST**3** and WST**4** move from measurement station **300** to exposure station **200** across the scrum area, main controller **20** (see FIG. **18**) can perform position control of wafer stages WST**3** and WST**4**, using first and second measurement head groups **72** and **73** (stage position measuring system **70**) and third measurement head group **79**H (auxiliary stage position measuring system **79**) by switching them according to the Y-position of wafer stages WST**3** and WST**4**.

Interferometer system **67**A (see FIG. **18**) measures positional information of wafer stage WST**3** when wafer stage WST**3** moves from exposure station **200** to measurement station **300** (or in a direction reverse thereto) passing through an area on the −X side (hereinafter, referred to as a first withdrawal area for the sake of convenience) excluding the scrum area on surface plate **14**A.

As shown in FIG. **15**, interferometer system **67**A includes two interferometers **18**YA_1 and **18**YA_2 and four X interferometers **18**XA_1, **18**XA_2, **18**XA_3 and **18**XA_4. Y interferometer **18**YA_2 is placed on the +Y side of surface plate **14**A. Y interferometer **18**YA_2 irradiates reflection surface **17**Y_2 with a measurement beam and receives a reflected beam from reflection surface **17**Y_2, thereby measuring the Y-position of reflection surface **17**Y_2, or more specifically, the Y-position of wafer stage WST**3**. Y interferometer **18**YA_1 is placed on the −Y side of surface plate **14**A. Similarly to Y interferometer **18**YA_2, for example, as shown in FIGS. **25** and **26**, Y interferometer **18**YA_1 irradiates reflection surface **17**Y_1 with a measurement beam and receives a reflected beam from reflection surface **17**Y_1, thereby measuring the Y-position of wafer stage WST**3**. Y interferometers **18**YA_1 and **18**YA_2 are mainly used when wafer stage WST**3** is located in the −Y side half and the +Y side half in the first withdrawal area on surface plate **14**A.

Meanwhile, X interferometers **18**XA_1 to **18**XA_4 are placed on the −X side of surface plate **14**A, at a predetermined distance in the Y-axis direction. X interferometer **18**XA_3 irradiates reflection surface **17**X with two measurement beams along an axis (measurement axis) parallel to the X-axis that is orthogonal to optical axis AX of projection optical system PL and reference axis LV, and receives reflected beams from reflection surface **17**X, thereby measuring the X-position and θz rotation (yawing amount) of wafer stage WST**3**. Likewise, X interferometers **18**XA_1, **18**XA_2 and **18**XA_4 also each irradiate reflection surface **17**X with two measurement beams and receive reflected beams from reflection surface **17**X, thereby measuring the X-position and θz rotation (yawing amount) of wafer stage WST**3**. In this case, the distance between X interferometers **18**XA_1 to **18**XA_4 adjacent to each other in the Y-axis direction is set such that any of the X interferometers is surely opposed to reflection surface **17**X of wafer stage WST**3**. Main controller **20** (see FIG. **18**) constantly measures the X-position and θz rotation (yawing amount) of wafer stage WST**3** that moves within the first withdrawal area on surface plate **14**A, using X interferometers **18**XA_1 to **18**XA_4 by switching them according to the Y-position of wafer stage WST**3**.

Similarly to interferometer system **67**A, interferometer system **67**B (see FIG. **18**) measures positional information of wafer stage WST**4** when wafer stage WST**4** moves from exposure station **200** to measurement station **300** (or in a direction reverse thereto) passing through an area on the +X side (hereinafter, referred to as a second withdrawal area for the sake of convenience) excluding the scrum area on surface plate **14**B.

As shown in FIG. **15**, interferometer system **67**B includes two interferometers **18**YB_1 and **18**YB_2 and four X interferometers **18**XB_1, **18**XB_2, **18**XB_3 and **18**XB_4. Y interferometer **18**YB_1 is placed on the −Y side of surface plate **14**B. Y interferometer **18**YB_1 irradiates reflection surface **17**Y_1 with a measurement beam and receives a reflected beam from reflection surface **17**Y_1, thereby measuring the Y-position of reflection surface **17**Y_1, or more specifically, the Y-position of wafer stage WST**4**. Y interferometer **18**YB_2 is placed on the +Y side of surface plate **14**B. Similarly to Y interferometer **18**YB_1, for example, as shown in FIGS. **30** to **32**, Y interferometer **18**YB_2 irradiates reflection surface **17**Y_2 with a measurement beam and receives a reflected beam from reflection surface **17**Y_2, thereby measuring the Y-position of wafer stage WST**4** interferometers **18**YB_1 and **18**YB_2 are mainly used when wafer stage WST**4** is located on the −Y side and the +Y side within the second withdrawal area on surface plate **14**B.

Meanwhile, X interferometers **18**XB_1 to **18**Xb_4 are placed on the +X side of surface plate **14**B, at a predetermined distance in the Y-axis direction. X interferometer **18**XB_3 irradiates reflection surface **17**X with two measurement beams along an axis (measurement axis) parallel to the X-axis that is orthogonal to optical axis AX of projection optical system PL and reference axis LV, and receives reflected beams from reflection surface **17**X, thereby measuring the X-position and θz rotation (yawing amount) of wafer stage WST**4**. Likewise, X interferometers **18**XB_1, **18**XB_2 and **18**XB_4 also each irradiate reflection surface **17**X with two measurement beams and receive reflected beams from reflection surface **17**X, thereby measuring the X-position and θz rotation (yawing amount) of wafer stage WST**4**. In this case, the distance between X interferometers **18**XB_1 to **18**XB_4 adjacent to each other in the Y-axis direction is set such that any of the X interferometers is surely opposed to reflection surface **17**X of wafer stage WST**4**. Main controller **20** constantly measures the X-position and θz rotation (yawing amount) of wafer stage WST**4** that moves within the second withdrawal area on surface plate **14**B, using X interferometers **18**XB_1 to **18**XB_4 by switching them according to the Y-position of wafer stage WST**4**.

As is obvious from FIG. **15**, each of Y interferometers **18**YA_1 and **18**YA_2 and X interferometers **18**XA_1 to **18**XA_4 that configure interferometer system **67**A is placed symmetric with each of Y interferometers **18**YB_1 and **18**YB_2 and X interferometers, **18**XB_1 to **18**XB_4 that configure interferometer system **67**B, with respect to reference axis LV.

Main controller **20** controls the position of each of wafer stages WST**3** and WST**4** by individually controlling stage driving systems **61**A and **61**B, based on the measurement values of interferometer systems **67**A and **67**B.

FIG. **18** shows a configuration of a control system of exposure apparatus **1000** of the present second embodiment. The control system is configured of main controller **20** as the central component. Main controller **20** includes a workstation (or a microcomputer) and the like, and performs overall control of the respective components of the exposure apparatus such as local liquid immersion device **8**, surface plate driving systems **60**A and **60**B and stage driving systems **61**A and **61**B described earlier.

Next, a parallel exposure operation using the two wafer stages WST**3** and WST**4** is described with reference to FIGS. **19** to **32**. Note that during the exposure operation, math controller **20** controls liquid supply device **5** and liquid recovery device **6** as described earlier and the liquid immersion area is constantly formed directly under tip lens **191** of projection optical system PL by a constant quantity of liquid Lq being held.

FIG. **19** shows a state where exposure by a step-and-scan method is performed on wafer W mounted on wafer stage WST**3** in exposure station **200**, and in parallel with this exposure, wafer exchange is performed between a wafer carrier mechanism (not illustrated) and wafer stage WST**4** at the second loading position.

As described earlier, the exposure operation by a step-and-scan method is performed by repeating an inter-shot movement (stepping between shots) operation of moving wafer stage WST**3** to a scanning starting position (acceleration starting position) for exposure of each shot area on wafer W based on the results of wafer alignment and reticle alignment and the like that have been performed beforehand, and a scanning exposure operation of transferring a pattern formed on reticle R onto each shot area on wafer W by a scanning exposure method. The results of the wafer alignment are, for example, obtained from information that is acquired by converting the arrangement coordinate of each shot area on wafer W obtained by the Enhanced Global Alignment (EGA) into the coordinate with the second fiducial mark as a reference.

In exposure apparatus **1000** of the present embodiment, during a series of the exposure operations described above, main controller **20** measures the position of wafer stage WST**3** using first measurement head group **72** of stage position measuring system **70** and controls the position of wafer stage WST**3** (wafer W) based on this measurement result.

The wafer exchange is performed by unloading a wafer that has been exposed from wafer stage WST**4** and loading a new wafer onto wafer stage WST**4** by the wafer carrier mechanism that is not illustrated, when wafer stage WST**4** is located at the second loading position described earlier.

During the wafer exchange described above, and after the wafer exchange, while wafer stage WST**4** stops at the second loading position, main controller **20** executes reset (resetting of the origin) of second measurement head group **73** (i.e. encoders **55**, **56** and **57** (and surface position measuring system **58**) of stage position measuring system **70**, prior to start of wafer alignment (and the other pre-processing measurements) with respect to the new wafer W.

When the wafer exchange (loading of the new wafer W) and the reset of stage position measuring system **70** (second measurement head group **73**) have been completed, main controller **20** detects the second fiducial mark on measurement plate FM**2** using primary alignment system AL**1**. Then, main controller **20** detects the position of the second fiducial mark with the index center of primary alignment system AL**1** serving as a reference, and based on the detection result and the result of position measurement of wafer stage WST4 by stage position measuring system **70** (second measurement head group **73**) at the time of the detection, computes the position coordinate of the second fiducial mark in an orthogonal coordinate system (alignment coordinate system) with reference axis La and reference axis LV as coordinate axes.

Next, as shown in FIG. **20**, main controller **20** performs the wafer alignment (EGA) while measuring the position coordinate of wafer stage WST**4** in the alignment coordinate system using stage position measuring system **70** (second measurement head group **73**). The details of the wafer alignment (EGA) are as described earlier. Then, based on the computation result of the position coordinate of the second fiducial mark and the results of the wafer alignment (EGA) described above, main controller **20** obtains the position coordinates of a plurality of shot areas on wafer W with the position of the second fiducial mark serving as the origin.

Normally, the above-described wafer exchange and wafer alignment sequence is completed earlier than the exposure sequence. Therefore, when the wafer alignment has been completed, main controller **20** drives wafer stage WST**4** in the +Y direction to move wafer stage WST**4** to the scrum area the area between exposure station **200** and measurement station **300**), as shown in FIG. **20**. At this point in time, wafer stage WST**4** goes out of a measurable range of stage position measuring system **70** (i.e. the measurement beams emitted from second measurement head group **73** move off from grating RG). Therefore, main controller **20** switches position measurement of wafer stage WST**4** within the XY plane from the measurement using stage position measuring system **70** (second measurement head group **73**) to the measurement using auxiliary stage position measuring system (third measurement head group) **79**, and based on the measurement results, controls the position of wafer stage WST**4**. Then, main controller **20** causes wafer stage WST**4** to wait within the scrum area until exposure on wafer W on wafer stage WST**3** is completed.

When the exposure on wafer W on wafer stage WST**3** has been completed, main controller **20** starts to drive wafer stages WST**3** and WST**4** severally toward the scrum position shown in FIG. **22**.

Then, in a state where wafer stages WST**3** and WST**4** have moved to the scrum position, wafer stage WST**3** and wafer stage WST**4** go into a scrum state where the end on the −Y side of wafer stage WST**3** and the end on the +Y side of wafer stage WST**4** are in proximity or in contact in the Y-axis direction. Accordingly, the upper surfaces of wafer stages WST**3** and WST**4** form a fully flat surface that is apparently integrated.

As shown in FIG. **22**, while keeping the scrum state described above, main controller **20** drives wafer stage WST**3** in the +Y direction as indicated by a black arrow based on the measurement result of stage position measuring system **70** (first measurement head group **72**), and at the same time, drives wafer stage WST**4** in the +Y direction as indicated by an outlined arrow based on the measurement result of auxiliary stage position measuring system (third measurement head group) **79**. According to the movement of both stages WST**3** and WST**4**, the liquid immersion area (liquid Lq) formed between tip lens **191** and wafer stage WST**3** moves onto wafer stage WST**4** as shown in FIG. **23**.

On the movement described above, wafer stage WST**3** goes out of a measurable range of stage position measuring system **70** (first measurement head group **72**) into the first withdrawal area on surface plate **14**A (i.e. the measurement beams emitted from first measurement head group **72** move off from grating RG). Therefore, main controller **20** switches position measurement of wafer stage WST**3** within the XY plane from the measurement using stage position measuring system **70** (first measurement head group **72**) to the measurement using Y interferometer **18**YA_2 and X interferometer **18**XA_4 of interferometer system **67**A and based or the measurement results, controls the position of wafer stage WST**3**.

Further, wafer stage WST**4** proceeds from the scrum area into exposure station **200**. Accordingly, the measurement beams emitted from third measurement head group **79**H that configures auxiliary stage position measuring system **79** move off from grating RG, and instead, the measurement beams emitted from first measurement head group **72** that configures stage position measuring system **70** are irradiated on grating RG. Therefore, main controller **20** switches position measurement of wafer stage WST**4** within the XY plane from the measurement using auxiliary stage position measuring system (third measurement head group) **79** to the measurement using stage position measuring system **70** (first measurement head group **72**), and based on the measurement results, controls the position of wafer stage WST**4**.

After the liquid immersion area (liquid Lq) has been moved onto wafer stage WST**4**, main controller **20** releases the scrum state of wafer stages WST**3** and WST**4**. Then, main controller **20** moves wafer stage WST**3** to the first loading position described previously through the first withdrawal area on surface plate **14**A. In this case, while measuring the position of wafer stage WST**3** using interferometer system **67**A, main controller **20** moves wafer stage WST**3** in the −X direction along the +Y end of surface plate **14**A as indicated by a black arrow in FIG. **23**, and further, moves wafer stage WST**3** in the −Y direction along the −X end of surface plate **14**A as indicated by black arrows in FIGS. **24** and **25**, and furthermore, moves wafer stage WST**3** in the +X direction along the −Y end of surface plate **14**A as indicated by a black arrow in FIG. **25**. At this point in time, as shown in FIGS. **24** to **26**, according to the Y-position of wafer stage WST**3**, the X interferometer used in the position measurement of wafer stage WST**3** is sequentially switched to X interferometers **18**XA_4, **18**XA_3, **18**XA_2, and **18**XA_1 and also the Y interferometer used in the position measurement of wafer stage WST**3** is switched from Y interferometer **18**YA_2 to Y interferometer **18**YA_1. Note that FIG. **25** shows a state where the interferometer is switched from Y interferometer **18**YA_2 to Y interferometer **18**YA_1.

As shown in FIG. **26**, after wafer stage WST**3** has reached the first loading position, main controller **20** switches the position measurement of wafer stage MT within the XY plane from the measurement using interferometer system **67**A to the measurement using stage position measuring system **70** (second measurement head group **73**).

In parallel with the movement of wafer stage WST**3** described above, main controller **20** drives wafer stage WST**4**, and as shown in FIG. **24**, sets the position of measurement plate FM**2** at directly under projection optical system PL. Then, the pair of first fiducial marks on measurement plate FM**2** are detected using reticle alignment systems RA_1 and RA_2, and the relative position of the projected images on the wafer of reticle alignment marks on reticle R that correspond to the first fiducial marks is detected.

Based on the relative positional information detected as above and the positional information of the respective shot areas on wafer W with the second fiducial mark serving as a reference that has been previously obtained, main controller **20** computes the relative positional relation between the projection position of the pattern of reticle R (the projection center of projection optical system PL) and each of the shot areas on wafer W mounted on wafer stage WST**4**. While controlling the position of wafer stage WST**4** based on the computation results, main controller **20** transfers the pattern of reticle R onto each shot area on wafer W mounted on wafer stage WST**4** by a step-and-scan method, in a similar manner to the previously-described manner. FIG. **26** shows a state where the pattern of reticle R is transferred onto each shot area on wafer W in this manner.

In parallel with the above-described exposure operation on wafer W on wafer stage WST**4**, main controller **20** performs the wafer exchange between the wafer carrier mechanism (not illustrated) and wafer stage WST**3** at the first loading position and mounts a new wafer W on wafer stage WST**3**.

Then, main controller **20** detects the second fiducial mark on measurement plate FM**1** using primary alignment system AL**1**. Note that, prior to the detection of the second fiducial mark, main controller **20** executes reset (resetting of the origin) of second measurement head group **73** (i.e. encoders **55**, **56** and **57** (and surface position measuring system **58**)) of stage position measuring system **70**, in a state where wafer stage WST**3** is located at the first loading position. After that, as shown in FIG. **27**, main controller **20** performs wafer alignment (EGA) using alignment systems AL**1** and AL2_1 to AL2_4, which is similar to the above-described one, with respect to wafer W on wafer stage WST**3**, while controlling the position of wafer stage WST**3**.

When the wafer alignment (EGA) with respect to wafer W on wafer stage WST**3** has been completed and also the exposure on wafer W on wafer stage WST**4** has been completed, main controller **20** drives wafer stages WST**3** and WST**4** toward the scrum position as shown in FIG. **28**. At this point in time, wafer stage WST**3** moves out of the measurable range of stage position measuring system **70** (i.e. the measurement beams emitted from second measurement head group **73** move off from grating RG). Therefore, main controller **20** switches position measurement of wafer stage WST**3** within the XY plan from the measurement using stage position measuring system **70** (second measurement head group **73**) to the measurement using auxiliary stage position measuring system (third measurement head group) **79**H, and based on the measurement result, controls the position of wafer stage WST**3**.

Then, in a state where wafer stages WST**3** and WST**4** have moved to the scrum position, wafer stage WST**3** and wafer stage WST**4** go into a scrum state of being in proximity or in contact in the Y-axis direction, as shown in FIG. **29**. Different from the scrum described previously, however, the +Y end of wafer stage WST**3** and the −Y end of wafer stage WST**4** are in proximity or in contact. Accordingly, the upper surfaces of wafer stages WST**3** and WST**4** form a fully flat surface that is apparently integrated.

While keeping the scrum state described above, main controller **20** drives wafer stage WST**4** in the +Y direction as indicated by a black arrow in FIG. **29** based on the measurement result of stage position measuring system **70**, and at the same time, drives wafer stage WST**3** in the +Y direction as indicated by an outlined arrow in FIG. **29** based on the measurement result of auxiliary stage position measuring system (third measurement head group) **79**H. According to the movement of both wafer stages WST**3** and WST**4**, the liquid immersion area (liquid Lq) formed between tip lens **191** and wafer stage WST**4** moves onto wafer stage WST**3**, as shown in FIG. **30**.

On the movement described above, wafer stage WST**4** goes out of a measurable range of stage position measuring system **70** (first measurement head group **72**) into the second withdrawal area on surface plate **14**B (i.e. the measurement beams emitted from first measurement head group **72** move off from grating RG). Therefore, main controller **20** switches position measurement of wafer stage WST**4** within the XY plane from the measurement using stage position measuring system **70** (first measurement head group **72**) to the measurement using Y interferometer **18**YB_2 and X interferometer **18**XB_4 of interferometer system **67**B, and based on the measurement results, controls the position of wafer stage WST**4**.

Further, wafer stage WST**3** proceeds from the scrum area into exposure station **200**. Accordingly, the measurement beams emitted from third measurement head group **79**H that configures auxiliary stage position measuring system **79** move off from grating RG, and instead, the measurement beams emitted from first measurement head group **72** that configure stage position measuring system **70** are irradiated on grating RG. Therefore, main controller **20** switches position measurement of wafer stage WST**3** within the XY plane from the measurement using auxiliary stage position measuring system (third measurement head group) **79** to the measurement using stage position measuring system **70** (first measurement head group **72**), and based on the measurement results, controls the position of wafer stage WST**3**.

After the liquid immersion area (liquid Lq) has been moved onto wafer stage WST**3**, main controller **20** releases the scrum state of wafer stages WST**3** and WST**4**. Then, main controller **20** moves wafer stage WST**4** to the second loading position through the withdrawal area on surface plate **14**B. In this case, while measuring the position of wafer stage WST**4** using interferometer system **67**B, main controller **20** moves wafer stage WST**4** in the +X direction along the +Y end of surface plate **14**B as indicated by a black arrow in FIG. **30**, and further, moves wafer stage WST**4** in the −Y direction along the +X end of surface plate **14**B as indicated by black arrows in FIGS. **31** and **32**, and furthermore, moves wafer stage WST**4** in the −X direction along the −Y end of surface plate **14**B as indicated by a black arrow in FIG. **32**. Accordingly, wafer stage WST**4** reaches the second loading position as shown in FIG. **19**. At this point in time, as shown in FIGS. **31**, **32** and **19**, according to the Y-position of wafer stage WST**4**, the X interferometer used in position measurement of wafer stage WST**4** is sequentially switched to X interferometers **18**XB_4, **18**XB_3, **18**XB_2, and **18**XB_1 and also the Y interferometer used in position measurement of wafer stage WST**4** is switched from Y interferometer **18**YB_2 to Y interferometer **18**YB_1. Note that FIG. **32** shows a state where the interferometers are switched from X interferometer **18**XB_3 to X interferometer **18**XB_2, and from Y interferometer **18**YB_2 to Y interferometer **18**YB_1.

As shown in FIG. **19**, after wafer stage WST**4** has reached the second loading position, main controller **20** switches the position measurement of wafer stage WST**4** within the XY plane from the measurement using interferometer system **67**B to the measurement using stage position measuring system **70** (second measurement head group **73**).

When the movement of the liquid immersion area (liquid Lq) has been completed, main controller **20** starts exposure on wafer W on wafer stage WST**3** in the procedure similar to the above-described one. In parallel with this exposure operation, main controller **20** exchanges wafer W that has been exposed on wafer stage WST**4** with a new wafer W, and executes the wafer alignment with respect to the new wafer W, in the procedure similar to the above-described one.

Afterwards, main controller **20** repeatedly executes the parallel processing operation using wafer stages WST**3** and WST**4** described above.

As described above, according to exposure apparatus **1000** of the present second embodiment, the function effect equivalent to exposure apparatus **100** of the first embodiment described earlier can be obtained. Further, according to exposure apparatus **1000** of the present second embodiment, since not only first measurement head group **72** and second measurement head group **73** of stage position measuring system **70** but also third measurement head group **79**H of auxiliary stage position measuring system **79** are placed at measurement bar **71**, main controller **20** can accurately move wafer stages WST**3** and WST**4** between measurement station **300** and exposure station **200** through the scrum area, based on the measurement results of first measurement head group **72** and second measurement head group **73** of stage position measuring system **70** and third measurement head group **79**H of auxiliary stage position measuring system **79**. Further, according to exposure apparatus **1000**, when the liquid immersion area (liquid Lq) formed on one of wafer stages WST**3** and WST**4** is moved onto the other of wafer stages WST**3** and WST**4**, main controller **20** measures positional information of one of the wafer stages using first measurement head group **72** of stage position measuring system **70** and measures positional information of the other of the wafer stages or both of the wafer stages using auxiliary stage position measuring system **79** (third measurement head group **79**H). Then, based on these measurement results, main controller **20** drives wafer stages WST**3** and WST**4** while maintaining the scrum state of making wafer stages WST**3** and WST**4** be in proximity (or be in contact) in the Y-axis direction, thereby moving the liquid immersion area (liquid Lq) formed on the one of the wafer stages onto the other of the wafer stages.

Incidentally, in the first and second embodiments above, while measurement bar **71** is configured of a beam-like member with the Y-axis direction serving as its longitudinal direction, measurement bar **71** can be configured of a beam-like member with the X-axis direction serving as its longitudinal direction. In such a case, the measurement bar is respectively arranged within exposure station **200** (below projection unit PU) and within the measurement station **300** (below alignment device **99**), and first and second measurement head groups **72** and **73** can be arranged at each of the measurement bars (to be first and second measurement bars), individually. For example, in the case where such first and second measurement bars are applied to the first embodiment described earlier, a head group similar to first measurement head group **72** (or the encoder heads included in first measurement head group **72**) can be placed, on the first measurement bar, at an appropriate distance that is less than the width of grating RG in the X-axis direction. In this case, while measuring positional information of the two wafer stages with high precision using a plurality of head groups, main controller **20** causes the two wafer stages to be in proximity or in contact in the X-axis direction based on the measurement results, and moves the two wafer stages in the longitudinal direction (X-axis direction) of the first measurement bar while maintaining the state (X scrum state), and thereby can move the liquid immersion area (liquid Lq) formed on one of the wafer stages onto the other of the wafer stages.

Incidentally, while the exposure apparatuses in the first and second embodiments above each have two surface plates so as to correspond to two wafer stages, the number of the surface plates is not limited thereto, and for example, one surface plate or three or more surface plates can be employed. Further, the number of the wafer stages is not limited to two, but one wafer stage or three or more wafer stages can be employed, and a measurement stage, for example, which has an aerial image measuring instrument, an uneven illuminance measuring instrument, an illuminance monitor, a wavefront aberration measuring instrument and the like, can be placed on the surface plate, which is disclosed in, for example, U.S. Patent Application Publication No. 2007/0201010.

Further, in the first and second embodiments above, while both ends of measurement bar **71** in the longitudinal direction are supported by main frame BD in a suspended manner, this is not intended to be limiting. For example, measurement bar **71** can be supported independently from main frame BD and a position sensor or the like can be provided so as to monitor and obtain the relative position between both of them. In this case, a drive mechanism for position adjustment can be arranged at the measurement bar. Further, the mid portion (which can be arranged at a plurality of positions) in the longitudinal direction of the measurement bar can be supported on the base board by an empty-weight canceller as disclosed in, for example, U.S. Patent Application Publication No. 2007/0201010.

Further, the motor to drive surface plates **14**A and **14**B on base board **12** is not limited to the planar motor by the electromagnetic force (Lorentz force) drive method, but for example, can be a planar motor (or a linear motor) by a variable magnetoresistance drive method. Further, the motor is not limited to the planar motor, but can be a voice coil motor that includes a mover fixed to the side surface of the surface plate and a stator fixed to the base board. Further, the surface plates can be supported on the base board via the empty-weight canceller as disclosed in, for example, U.S. Patent Application Publication No. 2007/0201010 and the like. Further, the drive directions of the surface plates are not limited to the directions of three degrees of freedom, but for example, can be the directions of six degrees of freedom, only the Y-axis direction, or only the XY two-axial directions. In this case, the surface plates can be levitated above the base board by static gas bearings (e.g. air bearings) or the like. Further, in the case where the movement direction of the surface plates can be only the Y-axis direction, the surface plates can be mounted on, for example, a Y guide member arranged extending in the Y-axis direction so as to be movable in the Y-axis direction.

Incidentally, the position of the border line that separates the surface plate or the base member into a plurality of sections is not limited to the position as in the first and second embodiments above. While the border line is set to include reference axis LV and intersect optical axis AX in the embodiments above, the border line can be set at another position, for example, in the case where, if the boundary is located in the exposure station, the thrust of the planar motor at the portion where the boundary is located weakens.

Further, in the first and second embodiments above, while the grating is placed on the lower surface of the fine movement stage, or more specifically, the surface that is opposed to the upper surface of the surface plate, this is not intended to be limiting, and the main section of the fine movement stage is made up of a solid member that can transmit light, and the grating can be placed on the upper surface of the main section. In this case, since the distance between the wafer and the grating is closer compared with the embodiments above, the Abbe error, which is caused by the difference in the Z-axis direction between the surface subject to exposure of the wafer that includes the exposure point and the reference surface (the placement surface of the grating) of position measurement of the fine movement stage by encoders **51**, **52** and **53**, can be reduced. Further, the grating can be formed on the back surface of the wafer holder. In this case, even if the wafer holder expands or the attachment position with respect to the fine movement stage shifts during exposure, the position of the wafer holder (wafer) can be measured according to the expansion or the shift.

Further, in the first and second embodiments above, while the case has been described as an example where the encoder system is equipped with the X head and the pair of Y heads, this is not intended to be limiting, and for example, one or two two-dimensional heads) (2D head(s)) whose measurement directions are the two directions that are the X-axis direction and the Y-axis direction can be placed inside the measurement bar. In the case of arranging the two 2D heads, their detection points can be set at the two points that are spaced apart in the X-axis direction at the same distance from the exposure position as the center, on the grating. Further, while the case has been described where the number of the heads per head group is one X head and two Y heads, the number of the heads can further be increased. Moreover, first measurement head group **72** on the exposure station **300** side can further have a plurality of head groups. For example, on each of the sides (the four directions that are the +X, +Y, −X and −Y directions) on the periphery of the head group placed at the position corresponding to the exposure position (a shot area being exposed on wafer W), another head group can be arranged. And, the position of the fine movement stage (wafer W) just before exposure of the shot area can be measured in a so-called read-ahead manner. Further, the configuration of the encoder system that configures fine movement stage position measuring system **70** is not limited to the one in the embodiment above and an arbitrary configuration can be employed. For example, a 3D head can also be used that is capable of measuring the positional information in each direction of the x-axis, the Y-axis and the Z-axis.

Further, in the first and second embodiments above, the measurement beams emitted from the encoder heads and the measurement beams emitted from the Z heads are irradiated on the gratings of the fine movement stages via a gap between the two surface plates or the light-transmitting section formed at each of the surface plates. In this case, as the light-transmitting section, holes each of which is slightly larger than a beam diameter of each of the measurement beams are formed at each of surface plates **14**A and **14**B taking the movement range of surface plate **14**A or **14**B as the countermass into consideration, and the measurement beams can be made to pass through these multiple opening sections. Further, for example, it is also possible that pencil-type heads are used as the respective encoder heads and the respective Z heads, and opening sections in which these heads are inserted are formed at each of the surface plates.

Incidentally, in the embodiment above, the case has been described as an example where according to employment of the planar motors as coarse movement stage driving systems **62**A and **62**B that drive wafer stages WST**1** and WST**2**, the guide surface (the surface that generates the force in the Z-axis direction) used on the movement of wafer stages WST**1** and WST**2** along the KY plane is formed by surface plates **14**A and **14**B that have the stator sections of the planar motors. However, the embodiment above is not limited thereto. Further, in the embodiment above, while the measurement surface (grating RG) is arranged on fine movement stages WFS**1** and WFS**2** and first measurement head group **72** (and second measurement head group **73**) composed of the encoder heads (and the Z heads) is arranged at measurement bar **71**, the embodiment above is not limited thereto. More specifically, reversely to the above-described case, the encoder heads (and the Z heads) can be arranged at fine movement stage WFS**1** and the measurement surface (grating RG) can be formed on the measurement bar **71** side. Such a reverse placement can be applied to a stage device that has a configuration in which a magnetic levitated stage is combined with a so-called H-type stage, which is employed in, for example, an electron beam exposure apparatus, an EUV exposure apparatus or the like. In this stage device, since a stage is supported by a guide bar, a scale bar (which corresponds to the measurement bar on the surface of which a diffraction grating is formed) is placed below the stage so as to be opposed to the stage, and at least a part (such as an optical system) of an encoder head is placed on the lower surface of the stage that is opposed to the scale bar. In this case, the guide bar configures the guide surface forming member. As a matter of course, another configuration can also be employed. The place where grating RG is arranged on the measurement bar **71** side can be, for example, measurement bar **71**, or a plate of a nonmagnetic material or the like that is arranged on the entire surface or at least one surface on surface plate **14**A (**14**B).

Further, in the embodiment above, while the case has been described where measurement bar **71** and main frame BD are integrated, this is not intended to be limiting, and measurement bar **71** and main frame BD can physically be separated. In such a case, a measurement device (e.g. an encoder and/or an interferometer, or the like) that measures the position (or displacement) of measurement bar **71** with respect to main frame BD (or a reference position), and an actuator or the like that adjusts the position of measurement bar **71** should be arranged, and based on the measurement result of the measurement device, main controller **20** and/or another controller should maintain the positional relation between main frame BD (and projection optical system PL) and measurement bar **71** in a predetermined relation (e.g. constant).

Further, a measurement system (sensor) that measures variation of measurement bar **71** with an optical method, a temperature sensor, a pressure sensor, an acceleration sensor for vibration measurement, and the like can be arranged at measurement bar **71**. Further, a distortion sensor and/or a displacement sensor and the like to measure variation of measurement bar **71** can be arranged. Then, it is also possible to correct the positional information obtained by fine movement stage position measuring system **70** and/or coarse movement stage position measuring systems **68**A and **68**B, using the values obtained by these sensors.

Further, in each of the embodiments above, while the case has been described where the present invention is applied to stage device (wafer stages) **50** of the exposure apparatus, this is not intended to be limiting, and the present invention can also be applied to reticle stage RST.

Incidentally, in the embodiment above, grating RG can be covered with a protective member, e.g. a cover glass, so as to be protected. The cover glass can be arranged to cover the substantially entire surface of the lower surface of main section **80**, or can be arranged to cover only a part of the lower surface of main section **80** that includes grating RG. Further, while a plate-shaped protective member is desirable because the thickness enough to protect grating RG is required, a thin film-shaped protective member can also be used depending on the material.

Besides, it is also possible that a transparent plate, on one surface of which grating RG is fixed or formed, has the other surface that is placed in contact with or in proximity to the back surface of the wafer holder and a protective member (cover glass) is arranged on the one surface side of the transparent plate, or the one surface of the transparent plate on which grating RG is fixed or formed is placed in contact with or in proximity to the back surface of the wafer holder without arranging the protective member (cover glass). Especially in the former case, grating RG can be fixed or formed on an opaque member such as ceramics instead of the transparent plate, or grating RG can be fixed or formed on the back surface of the wafer holder. In the latter case, even if the wafer holder expands or the attachment position with respect to the fine movement stage shifts during exposure, the position of the wafer holder (wafer) can be measured according to the expansion or the shift. Or, it is also possible that the wafer holder and grating RG are merely held by the conventional fine movement stage. Further, it is also possible that the wafer holder is formed by a solid glass member, and grating RG is placed on the upper surface (wafer mounting surface) of the glass member.

Incidentally, in the embodiment above, while the case has been described as an example where the wafer stage is a coarse/fine movement stage that is a combination of the coarse movement stage and the fine movement stage, this is not intended to be limiting. Further, in the embodiment above, while fine movement stages WFS**1** and WFS**2** can be driven in all the directions of six degrees of freedom, this is not intended to be limiting, and the fine movement stages should be moved at least within the two-dimensional plane parallel to the XY plane. Moreover, fine movement stages WFS**1** and WFS**2** can be supported in a contact manner by coarse movement stages WCS**1** and WCS**2**. Consequently, the fine movement stage driving system to drive fine movement stage WFS**1** or WFS**2** with respect to coarse movement stage WCS**1** or WCS**2** can be a combination of a rotary motor and a ball screw (or a feed screw).

Incidentally, the fine movement stage position measuring system can be configured such that the position measurement can be performed in the entire area of the movement range of the wafer stages. In such a case, the coarse movement stage position measuring systems become unnecessary.

Incidentally, the wafer used in the exposure apparatus of the embodiment above can be any one of wafers with various sizes, such as a 450-mm wafer or a 300-mm wafer.

Incidentally, in each of the embodiments above, while the case has been described where the exposure apparatus is the liquid immersion type exposure apparatus, this is not intended to be limiting. The embodiment above can suitably be applied to a dry type exposure apparatus that performs exposure of wafer W without liquid (water). **1**

Incidentally, in the first and second embodiments above, while the case has been described where the exposure apparatus is a scanning stepper, this is not intended to be limiting, and each of the embodiments above can also be applied to a static exposure apparatus such as a stepper. Even in the stepper or the like, occurrence of position measurement error caused by air fluctuation can be reduced to, almost zero by measuring the position of a stage on which an object that is subject to exposure is mounted using an encoder. Therefore, it becomes possible to set the position of the stage with high precision based on the measurement values of the encoder, and as a consequence, high-precision transfer of a reticle pattern onto the object can be performed. Further, each of the embodiments above can also be applied to a reduced projection exposure apparatus by a step-and-stitch method that synthesizes a shot area and a shot area.

Further, the magnification of the projection optical system in the exposure apparatus in the first and second embodiments above is not only a reduction system, but also can be either an equal magnifying system or a magnifying system, and the projection optical system is not only a dioptric system, but also can be either a catoptric system or a catadioptric system, and in addition, the projected image can be either an inverted image or an erected image.

Further, illumination light IL is not limited to ArF excimer laser light (with a wavelength of 193 nm), but can be ultraviolet light such as KrF excimer laser light (with a wavelength of 248 nm), or vacuum ultraviolet light such as F_2 laser light (with a wavelength of 157 nm). As disclosed in, for example, U.S. Pat. No. 7,023,610, a harmonic wave, which is obtained by amplifying a single-wavelength laser beam in the infrared or visible range emitted by a DFB semiconductor laser or fiber laser with a fiber amplifier doped with, for example, erbium for both erbium and ytteribium), and by converting the wavelength into ultraviolet light using a nonlinear optical crystal, can also be used as vacuum ultraviolet light.

Further, in the first and second embodiments above, illumination light IL of the exposure apparatus is not limited to the light having a wavelength more than or equal to 100 nm, and it is needless to say that the light having a wavelength less than 100 nm can be used. For example, the each of the embodiments above can be applied to an EUV (Extreme Ultraviolet) exposure apparatus that uses EUV light in a soft X-ray range (e.g. a wavelength range from 5 to 15 nm). In addition, the each of the embodiments above can also be applied to an exposure apparatus that uses charged particle beams such as an electron beam or an ion beam.

Further, in the first and second embodiments above, a light transmissive type mask (reticle) is used, which is obtained by forming a predetermined light-shielding pattern (or a phase pattern or a light-attenuation pattern) on a light-transmitting substrate, but instead of this reticle, as disclosed in, for example, U.S. Pat. No. 6,778,257, an electron mask (which is also called a variable shaped mask, an active mask or an image generator, and includes, for example, a DMD (Digital Micromirror Device) that is a type of a non-emission type image display element (spatial light modulator) or the like) on which a light-transmitting pattern, a reflection pattern, or an emission pattern is formed according to electronic data of the pattern that is to be exposed can also be used. In the case of using such a variable shaped mask, a stage on which a wafer, a glass plate or the like is mounted is scanned relative to the variable shaped mask, and therefore the equivalent effect to the embodiments above can be obtained by measuring the position of this stage using an encoder system.

Further, as disclosed in, for example, PCT International Publication No. 2001/035168, the each of the embodiments above can also be applied to an exposure apparatus (a lithography system) in which line-and-space patterns are formed on wafer W by forming interference fringes on wafer W.

Moreover, the each of the embodiments above can also be applied to an exposure apparatus that synthesizes two reticle patterns on a wafer via a projection optical system and substantially simultaneously performs double exposure of one shot area on the wafer by one scanning exposure, as disclosed in, for example, U.S. Pat. No. 6,611,316.

Incidentally, an object on which a pattern is to be formed (an object subject to exposure on which an energy beam is irradiated) in the first and second embodiments above is not limited to a wafer, but may be another object such as a glass plate, a ceramic substrate, a film member, or a mask blank.

The usage of the exposure apparatus is not limited to the exposure apparatus used for manufacturing semiconductor devices, but the present invention can be widely applied also to, for example, an exposure apparatus, for manufacturing liquid crystal display elements in which a liquid crystal display element pattern is transferred onto a rectangular glass plate, and to an exposure apparatus for manufacturing organic EL, thin-film magnetic heads, imaging devices (such as CCDs), micromachines, DNA chips or the like. Further, the each of the embodiments above can also be applied to an exposure apparatus that transfers a circuit pattern onto a glass substrate, a silicon wafer or the like not only when producing microdevices such as semiconductor devices, but also when producing a reticle or a mask used in an exposure apparatus such as an optical exposure apparatus, an EUV exposure apparatus, an X-ray exposure apparatus, and an electron beam exposure apparatus.

Incidentally, the disclosures of all publications, the PCT international Publications, the U.S. patent application Publications and the U.S. patents that are cited in the description so far related to exposure apparatuses and the like are each incorporated herein by reference.

Electron devices such as semiconductor devices are manufactured through the following steps: a step where the function/performance design of a device is performed; a step where a reticle based on the design step is manufactured; a step where a wafer is manufactured using a silicon material; a lithography step where a pattern of a mask (the reticle) is transferred onto the wafer with the exposure apparatus (pattern formation apparatus) of the embodiments described earlier and the exposure method thereof; a development step where the exposed wafer is developed; an etching step where an exposed member of an area other than an area where resist remains is removed by etching; a resist removing step where the resist that is no longer necessary when the etching is completed is removed; a device assembly step (including a dicing process, a bonding process, and a packaging process); an inspection step; and the like. In this case, in the lithography step, the exposure method described earlier is executed using the exposure apparatus of the embodiments above and device patterns are formed on the wafer, and therefore, the devices with high integration degree can be manufactured with high productivity.

While the above-described embodiments of the present invention are the presently preferred embodiments thereof, those skilled in the art of lithography systems will readily recognize that numerous additions, modifications, and substitutions may be made to the above-described embodiments without departing from the spirit and scope thereof. It is intended that all such modifications, additions, and substitutions fall within the scope of the present invention, which is best defined by the claims appended below.

What is claimed is:

1. An exposure apparatus that exposes an object with an energy beam via an optical system and a liquid, the apparatus comprising:

a first and a second movable bodies which independently move on a guide surface parallel to a two-dimensional plane while each holding the object, and at each of which a measurement surface parallel to the two-dimensional plane is arranged;

a guide surface forming member that forms the guide surface;

a liquid supply device that supplies the liquid to a space between the optical system and the object held by the first or second movable body;

a first measurement system that irradiates the measurement surface of the first or second movable body that moves within a first area, with a measurement beam from a side opposite to the optical system with respect to the guide surface forming member, and receives light from the measurement surface, thereby obtaining positional information of the first or second movable body; and

a second measurement system that, when one of the first and second movable bodies located within the first area moves in proximity to the other of the first and second movable bodies and thereby the liquid supplied on the one of the movable bodies moves onto the other of the movable bodies, obtains at least positional information of the other of the movable bodies.

2. The exposure apparatus according to claim **1**, wherein the first measurement system irradiates the measurement beam on a point on the measurement surface that corresponds to an exposure position that is a center of an irradiation area of the energy beam irradiated on the object.

3. The exposure apparatus according to claim **1**, wherein the second measurement system irradiates the measurement surface of the other of the movable bodies that moves within an overlapping area at least a part of which overlaps the first area within the two-dimensional plane, with a measurement beam from a side opposite to the optical system with respect to the guide surface forming member, and receives light from the measurement surface, thereby obtaining positional information of the other of the movable bodies.

4. The exposure apparatus according to claim **3**, wherein the second measurement system, together with the first measurement system, irradiates the measurement beam on the measurement surfaces of the first and second movable bodies located within the at least a part of the overlapping area.

5. The exposure apparatus according to claim **1**, wherein the second measurement system includes an interferometer system that obtains positional information of the first and second movable bodies by irradiating a measurement beam on reflection surfaces that are respectively arranged at the first and second movable bodies and receiving light from the reflection surfaces.

6. The exposure apparatus according to claim **1**, further comprising:

a mark detecting system that detects a plurality of marks arranged on the object held by the first or second movable body within a second area that is away from the first area.

7. The exposure apparatus according to claim **6**, wherein the first and second movable bodies move between the first and second areas passing through a measurement area where the second measurement system obtains the positional information of the first and second movable bodies.

8. The exposure apparatus according to claim **6**, further comprising:

a third measurement system that obtains positional information of the first or second movable body by irradiating the measurement surface of the first or second movable body that moves within the second area, with a measurement beam from a side opposite to the optical system with respect to the guide surface forming member, and receiving light from the measurement surface.

9. The exposure apparatus according to claim **8**, wherein the third measurement system irradiates the measurement beam on a point on the measurement surface that corresponds to a detection center of the mark detecting system.

10. The exposure apparatus according to claim **8**, wherein at least a part of the third measurement system is installed at a second support member supported by a first support member that supports the optical system.

11. The exposure apparatus according to claim **10**, wherein the guide surface forming member is a surface plate which is placed on the optical system side of the second support member so as to be opposed to the movable body and which has the guide surface formed on one surface thereof on a side opposed to the movable body, and

the second support member is supported by the surface plate without being in contact with the surface plate.

12. The exposure apparatus according to claim 10, wherein at least a part of the first measurement system is placed at the second support member.

13. The exposure apparatus according to claim 10, wherein at least a part of the second measurement system is placed at the second support member.

14. The exposure apparatus according to claim 1, wherein at least one of the first and second movable bodies includes a first movable body member that is movable on the guide surface while holding the object, and a second movable body member that is placed on an outer side of the first movable body member and is movable on the guide surface while supporting the first movable body member relatively movable, and

the first and second movable body members are in proximity to each other when the first and second movable bodies are in proximity.

15. The exposure apparatus according to claim 14, further comprising:

a relative drive system that drives the first movable body member relative to the second movable body member.

16. The exposure apparatus according to claim 14, further comprising:

a relative position measuring system that obtains relative positional information between the first movable body member and the second movable body member.

17. The exposure apparatus according to claim 1, wherein the measurement surface is arranged on a first surface of each of the first and second movable bodies, the first surface being opposed to the guide surface and parallel to the two-dimensional plane, and

the object is mounted on a second surface of each of the first and second movable bodies, the second surface being on a side opposite to the first surface and parallel to the two-dimensional plane.

18. The exposure apparatus according to claim 1, wherein on the measurement surface, a grating whose periodic direction is in a direction parallel to the two-dimensional plane is arranged, and

the first measurement system receives diffraction light from the measurement surface.

19. A device manufacturing method, comprising:

exposing an object using the exposure apparatus according to claim 1; and

developing the exposed object.

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